May 1998

MONITORING THE MIGRATIONS OF WILD SNAKE RIVER SPRING/SUMMER CHINOOK SALMON SMOLTS

Annual Report 1997

DOE/BP-18800-6

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views of this report are the author's and do not necessarily represent the views of BPA.

This document should be cited as follows:

Achord, Stephen, M. Brad Eppard, Eric Hockersmith, Benjamin Sandford, Gordon Axel, Gene Matthews - National Marine Fisheries Service, Monitoring the Migrations of Wild Snake River Spring/Summer Chinook Salmon Smolts, 1997 Report to Bonneville Power Administration, Contract No. 1991BP18800, Project No. 199102800, 86 electronic pages (BPA Report DOE/BP-18800-6)

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MONITORING THE MIGRATIONS OF WILD SNAKE RIVER SPRING/SUMMER CHINOOK SALMON SMOLTS, 1997

by

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Report of Research

Funded by

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, Oregon 97208-3621

Project 91-028
Contract DE-AI79-91BP18800

and

Fish Ecology Division
Northwest Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
2725 Montlake Boulevard East
Seattle, Washington 98112-2097

May 1998

ABSTRACT

In August 1996, we PIT tagged and released 1,360 wild chinook salmon parr in the South Fork of the Salmon River and two of its tributaries in Idaho. During spring and summer 1997, the overall adjusted percentage of PIT-tagged fish from Idaho detected at six downstream dams averaged 18.3% (range 16.0 to 27.3% depending on stream of origin). Peak detections of all wild spring/summer chinook salmon smolts (from Idaho and Oregon) at Lower Granite Dam occurred during variable but increasing river flows in April. High river flows from mid-April to mid-May moved most of these fish through Lower Granite Dam, with 50 and 90% passage occurring on 24 April and 21 May, respectively. From 1989 to 1996, peak detections of wild spring/summer chinook salmon smolts were highly variable and generally independent of river flows before about 9 May at this dam; however, during these years (including 1997), peak detections of wild fish coincided with periods of peak flow at the dam from 9 May to the end of May. In both 1995 and 1996, in excess of 90% of the wild fish had migrated past Lower Granite Dam by the time peak flows occurred in June. In 1989, we observed a period of peak detections of wild fish that coincided with peak flows at the dam in June. After examining chinook salmon smolt passage timing at the dams over the last 9 years, it has become clear that flow is only one of several factors that influence passage timing. Other factors, such as annual climatic conditions, water temperature, turbidity, physiological development, variability in stock behavior, fish size, and other yet unknown conditions may equally affect wild smolt passage timing at dams. As additional environmental monitors and traps are installed in study streams, we will be able to more accurately monitor parr and smolt movements out of rearing areas and examine the relationships of these movements to environmental parameters within the streams. Mapped over time, this information will provide the basis for accurately predicting the migrational timing of different wild stocks as they migrate downstream through the hydropower system.

EXECUTIVE SUMMARY

We PIT tagged wild spring/summer chinook salmon parr in the Snake River Basin in 1996 and subsequently monitored these fish during their smolt migration through Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams during 1997. This report details our research and findings which are summarized below.

1) In August 1996, we PIT tagged and released 1,360 wild chinook salmon parr in the South Fork of the Salmon River and two of its tributaries.
2) Average overall observed mortality from collection, handling, tagging, and after a 24-hour holding period was 0.5%. No PIT tags were lost during this 24-hour holding period to assess delayed mortality from collection, handling, and tagging.
3) In 1997, the overall adjusted percentage of PIT-tagged fish detected at six dams compared to the number of fish released averaged 18.3% (range 16.0 to 27.3%, depending on stream of origin).
4) Fish that were larger at release were detected at a significantly higher rate the following spring and summer than their smaller cohorts ($P = 0.0001$).
5) Wild fish migrating through the dams in April were significantly larger at release than fish migrating in May ($P < 0.0001$).
6) In 1997, peak detections of all wild spring/summer chinook salmon smolts at Lower Granite Dam occurred during variable but increasing river flows in April. High river flows from mid-April to mid-May moved most of these fish through the dam. From 1989 to 1996, peak detections of wild spring/summer chinook salmon smolts at Lower Granite Dam were highly variable and generally independent of river flows before about 9 May; however, during these

years (including 1997), peak detections of wild fish coincided with periods of peak flow at the dam from 9 May to the end of May. In both 1995 and 1996, well over 90% of the wild fish had migrated past Lower Granite Dam by the time peak flows occurred in June. In 1989, we observed a period of peak detections of wild fish that coincided with peak flows at the dam in June.

7) In 1997, 50 and 90% passage dates of PIT-tagged fish from wild stocks combined (Idaho and Oregon streams) at Lower Granite Dam occurred on 24 April and 21 May, respectively. However, in 1995 and 1996 few wild fish were marked as parr in Idaho streams; therefore, the 1996 and 1997 detections at Lower Granite Dam were composed of 91 and 73.5% (respectively) fish from Oregon streams. Therefore, we caution against comparing migration timing in 1996 and 1997 to previous years, since in all previous years less than 50% of wild fish detections were from Oregon streams.

8) Before 1995, we observed a 2-week shift in timing of wild stocks passing Lower Granite Dam between relatively warm and relatively cold years. In the cold years of 1989, 1991, and 1993, 50% of all wild fish passed the dam by mid-May, while 90% passed by mid-June (except during 1993, when high flows moved 90% through the dam by the end of May). In the warm years of 1990, 1992, and 1994, 50% of all wild fish passed this dam from 29 April to 4 May, and 90% passed by the end of May. In 1995, we experienced intermediate weather conditions in late winter and early spring (compared to the previous 6 years) and observed intermediate passage timing at the dam, with 50 and 90% passage on 9 May and 5 June, respectively.

9) After examining chinook salmon smolt passage timing at the dams over the last 9 years, it has become clear that flow is only one of several factors that influence passage timing. Other

factors, such as annual climatic conditions, water temperature, turbidity, physiological development, variability in stock behavior, fish size, and other yet unknown conditions may equally affect wild smolt passage timing at dams. As additional environmental monitors and traps are installed in study streams, we can more accurately monitor parr and smolt movements out of rearing areas and examine the relationships to environmental parameters within the streams. Mapped over time, this information will be used to accurately predict when different wild stocks will arrive at the first dam.

CONTENTS

INTRODUCTION

Project Goals

The goals of this study are to 1) characterize the migration timing of different wild stocks of Snake River spring/summer chinook salmon smolts at dams on the Snake and Columbia Rivers, 2) determine if consistent migration patterns are apparent, and 3) determine what environmental factors influence migration timing.

Background

In 1988, the National Marine Fisheries Service (NMFS) began a cooperative study with the U.S. Army Corps of Engineers (COE) to mark wild Snake River spring and summer chinook salmon parr with Passive Integrated Transponder (PIT) tags for transportation research. This project continued through mid-1991, with migrating smolts monitored as they passed Lower Granite, Little Goose, and McNary Dams during spring and summer 1989-1991 (Matthews et al. 1990, 1992; Achord et al. 1992, 1996b). Information from this study demonstrated that the timing of various wild stocks through Lower Granite Dam differed among streams of origin and also differed from timing patterns of hatchery-reared fish. Generally, the migrations of wild spring chinook salmon were later and more protracted than those of their hatchery-reared counterparts and exhibited variable timing patterns over the 3 years. Conversely, the migrations of wild summer chinook salmon were earlier than those of their hatchery counterparts, though also more protracted.

The present study began with the 1992 migration of wild chinook salmon smolts (Achord et al. 1994). Warm weather and high water temperatures in late winter and spring appeared to elicit an early migration timing for all wild smolts in 1992: the migration timing of wild spring chinook salmon smolts was earlier in 1992 than in the previous

3 years. Also, most wild summer chinook salmon smolts migrated earlier than wild spring chinook salmon smolts. However, as was observed during previous years, all wild stocks exhibited protracted and variable migration timing at Lower Granite Dam.

In 1993, cold weather and low water temperatures from late winter to early summer appeared to elicit a late migration timing; however, high flows during the third week of May moved a large portion of wild spring/summer chinook salmon through the dams (Achord et al. 1995a). As observed in previous years, wild stocks exhibited variable migration timing at Lower Granite Dam; however, the middle 80% passage time of wild fish stocks at the dam was more compressed in 1993 than in earlier years.

In 1994, migration timing of wild spring/summer chinook salmon smolts at Lower Granite Dam was similar to timing in 1990 and 1992, with peak passage in all 3 years occurring in April; however, peak detections of fish from individual streams in 1994 occurred from late April to late May (Achord et al. 1995b). As observed in 1990 and 1992, 1994 temperatures were high in late winter and spring.

Before 1995, we observed a 2-week shift in timing of wild fish at Lower Granite Dam between relatively warm and relatively cold years. In the cold years of 1989, 1991, and 1993, 50% of all wild fish passed the dam by mid-May, and 90% passed by mid-June (except in 1993, when high flows moved 90% through the dam by the end of May). In the warm years of 1990, 1992, and 1994, 50% of all wild fish passed this dam from 29 April to 4 May, and 90% passed by the end of May. In 1995, we experienced intermediate weather conditions in late winter and early spring (compared to the previous 6 years) and observed intermediate passage timing at the dam, with 50 and 90% passage occurring on 9 May and 5 June, respectively (Achord et al. 1996a). Sustained high flows from mid-May to early June in that year moved the later half of the

wild fish migration through the dam at a more uniform rate than in previous years, and over 90% passed by the time peak flows occurred at the dam on 6 June.

In 1996, as observed in all previous migration years, peak detections of all wild fish at Lower Granite Dam were highly variable and generally independent of river flows before about 9 May; however, in these years, peak detections of wild fish coincided with periods of peak flow at the dam from 9 May to the end of May (Achord et al. 1997). In 1996, 50 and 90% passage dates of PIT-tagged fish from wild stocks combined (Idaho and Oregon streams) at Lower Granite Dam occurred on 3 and 22 May, respectively. However, unlike previous years, few wild fish from Idaho streams were marked as parr in 1995; as a result, the 1996 detections at the dam were composed of 91% fish from Oregon streams. Therefore, we caution against comparing migration timing in 1996 to previous years, since in all previous years less than 50% of wild fish detections were from Oregon streams.

Prior to 1992, decisions on dam operations and use of stored water relied on recoveries of branded hatchery fish, index counts at traps and dams, and flow patterns at the dams. In 1992, a more complete approach was undertaken, with the addition of PIT-tag detections of several wild spring and summer chinook salmon stocks at Lower Granite Dam. We initiated development of a database on wild fish, which addresses several goals of the Columbia River Basin Fish and Wildlife Program of the Pacific Northwest Electric Power Planning Council and Conservation Act (1980). Section 304(d) of the program states: "The monitoring program will provide information on the migrational characteristics of the various stocks of salmon and steelhead within the Columbia Basin." Further, Section 201(b) urges conservation of genetic diversity, which will only be possible if wild stocks are preserved. The advent of PIT-tag technology has

provided the opportunity to precisely track the smolt migrations of many wild stocks as they pass through the hydroelectric complex on their way to the ocean.

This report provides information on PIT tagging of wild chinook salmon parr in 1996 and the subsequent monitoring of these fish. Fish were monitored as they migrated through some juvenile migrant traps in 1996 and 1997 as well as Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams during 1997.

FISH COLLECTION AND TAGGING

In 1992, Oregon Department of Fish and Wildlife (ODFW) began PIT tagging wild chinook salmon parr in the Grande Ronde and Imnaha River drainages in northeast Oregon. All tagging, detection, and timing information for fish from these streams in 1996-1997 will be reported by ODFW. However, with ODFW's concurrence, NMFS will continue to report the timing at Lower Granite Dam of fish from those streams in Oregon where we had PIT tagged wild chinook salmon from 1988 to 1991.

We collected and PIT tagged wild chinook salmon parr from three streams in the South Fork of the Salmon River drainage during August 1996 (Fig. 1). Due to extremely low numbers of returning adult spring/summer chinook salmon to Idaho in 1995 and subsequent low numbers of parr in the streams in 1996, the Idaho Department of Fish and Game (IDFG) allowed collection of parr only in the drainage of the South Fork of the Salmon River.

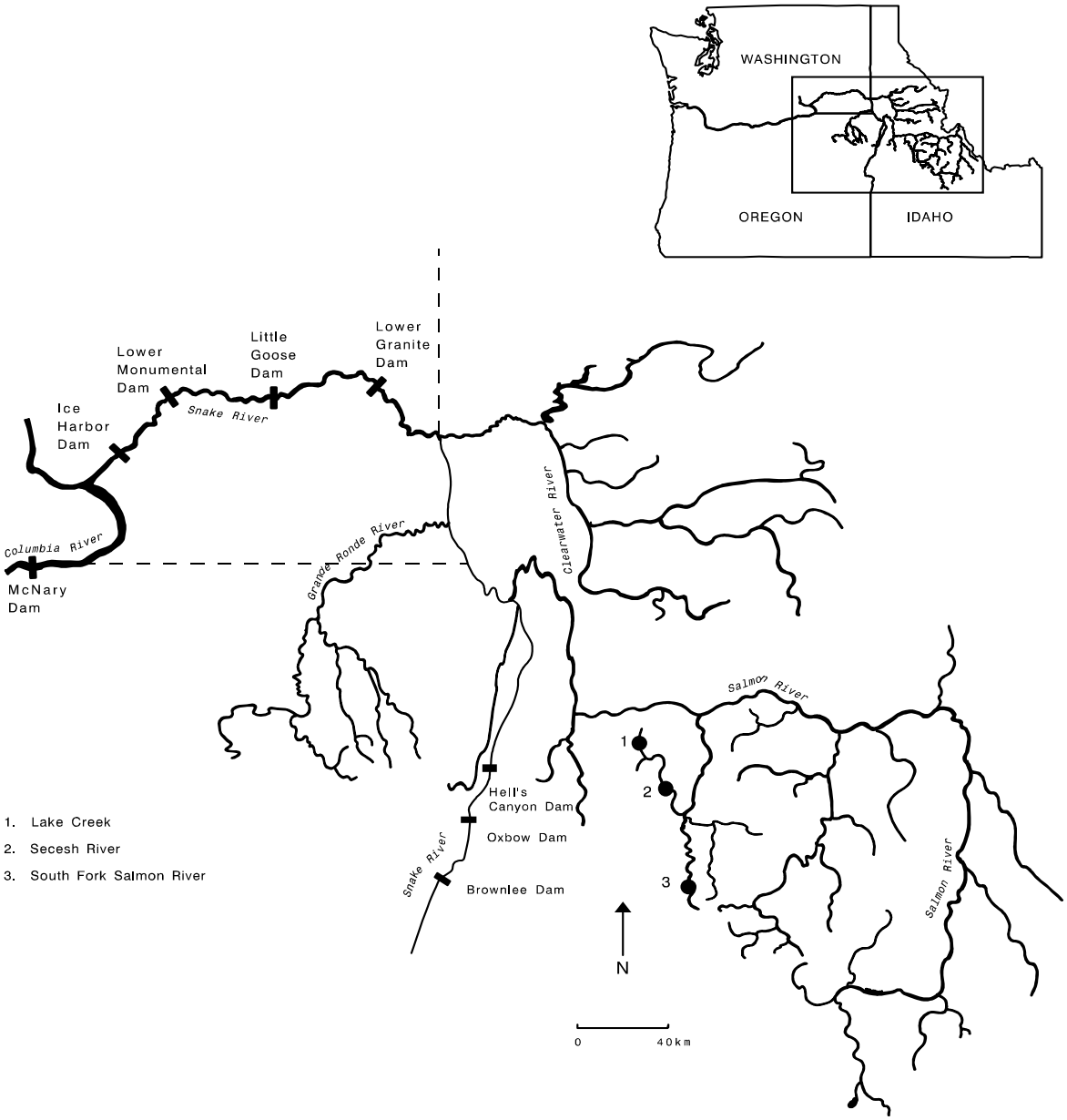

Figure 1. Study area where wild spring/summer chinook salmon parr were PIT tagged during 1996.

Collection and PIT-tagging procedures described by Matthews et al. (1990) and Achord et al. (1994, 1995a, 1995b) were used for our field work in 1996. From 20 to 30 August 1996, we collected 1,455 wild chinook salmon parr in Idaho over a distance of about 16 stream kilometers (Table 1 and Appendix Tables 1 and 6). Of these fish, 1,360 were PIT tagged and released back into the streams. Numbers released per stream ranged from 260 in the Secesh River to 700 in the South Fork of the Salmon River. Fork lengths of tagged and released wild fish ranged from 51 to 125 mm (mean 67 mm), and weights ranged from 1.7 to 24.3 g (mean 4.4 g).

Steelhead and sculpins were the most abundant species other than chinook salmon observed during electrofishing operations (Tables 1 and 2). However, numbers of fish do not represent total abundances of fish in the areas of collection.

Mortality associated with collection and tagging procedures was low, and 24-hour tag loss was zero (Table 3 and Appendix Table 2). Average collection mortality was 0.5%, and average tagging and 24-hour delayed mortality was 0.1%. The average overall observed mortality was 0.5%.

DETECTIONS AT TRAPS

During fall 1996 and spring 1997, a juvenile migrant fish trap was operated at Knox Bridge on the South Fork of the Salmon River. Also during spring 1997, juvenile migrant fish traps were operated on the lower Salmon River near Whitebird, Idaho, and on the Snake River at Lewiston, Idaho. All traps were operated by IDFG.

Table 1. Summary of collection, PIT-tagging, and release of wild chinook salmon and steelhead parr with average fork lengths and weights and approximate distances covered in streams of Idaho during August 1996.

Tagging location	Number collected	Number tagged and released	Average length of tagged fish (mm)	Average weight of tagged fish (g)	Kilometers covered in streams
		Chinook Salmon			
S. Fork Salmon River	780	700	64	3.6	5
Secesh River	267	260	70	5.1	6
Lake Creek	408	400	71	5.0	5
Totals	1,455	1,360	67	4.4	16
		Steelhead[a]			
S. Fork Salmon River	280	146	--	---	--
Secesh River	494	137	--	---	--
Lake Creek	149	93	--	---	--
Totals	923	376	--	---	--

[a] Steelhead were PIT-tagged at the request of Idaho Department of Fish and Game.

Table 2. Summary of species other than chinook salmon and steelhead parr observed during electrofishing operations in three streams in Idaho in August 1996 (Note: Numbers in parentheses represent brook trout sampled for whirling disease analysis).

Stream	Brook trout	Whitefish	Bull trout	Sculpin	Dace
S. Fork Salmon River	(12)	0	0	351	6
Secesh River	230 (60)	0	12	514	35
Lake Creek	363	41	34	662	4
Totals	605 (72)	41	46	1,527	45

Table 3. Mortality and tag loss for wild chinook salmon parr collected and PIT tagged in Idaho, August 1996.

Tagging location	Mortality (%)				24-hour tag loss (%)
	Collection	Tagging	24-hour	Overall	
S. Fork Salmon River	0.3	0.0	0.0	0.3	0.0
Secesh River	0.7	0.0	0.0	0.7	0.0
Lake Creek	0.7	0.3	0.0	1.0	0.0
Averages	0.5	0.1	0.0	0.5	0.0

A total of 30 previously PIT-tagged wild spring/summer chinook salmon from the South Fork of the Salmon River were detected at the Knox Bridge juvenile migrant fish trap in fall 1996 and spring 1997. Of these, 29 were recaptured at the trap in the fall. They had grown an average of 4.5 mm in length (range 0-10 mm) over an average of 34.2 days (range 7-60 days). One wild fish from the summer tagging was detected at the trap in the spring. It had grown 9 mm in length in 212 days. The overall average length of fish released from the South Fork of the Salmon River in summer (64 mm), was similar to the overall average length at release for fish detected at the Knox Bridge trap in the fall (65 mm). This implies that size at tagging had little, if any, effect on post-tagging mortality. None of the summer PIT-tagged fish from the South Fork of the Salmon River drainage were detected at the two downstream juvenile migrant fish traps on the Salmon and Snake Rivers in spring 1997.

DETECTIONS AT DAMS

During spring, summer, and fall 1997, surviving chinook salmon PIT tagged for this study migrated volitionally downstream through hydroelectric complexes on the Snake and Columbia Rivers. Of the eight dams the smolts passed, these four were equipped with complete smolt collection and PIT-tag monitoring systems: Lower Granite, Little Goose, and Lower Monumental Dams on the Snake River, and McNary Dam on the Columbia River (Fig. 1). Below McNary Dam, two additional dams, John Day and Bonneville Dams, were equipped with PIT-tag detection gear within their collection and sampling systems.

At the four smolt-collection dams, all smolts guided from the turbine intakes into the juvenile bypass systems were electronically interrogated for PIT tags as they passed through the distribution flumes, which are positioned downstream from the outlet orifices of the fish and debris separators. The PIT-tag monitor systems were the same as those described by Prentice et

al. (1990). Dates and times to the nearest second were automatically recorded on a computer as PIT-tagged fish passed through the numbered detector coils in the fish distribution flumes. All detection data were transferred once each day to the mainframe computer operated by the Pacific States Marine Fisheries Commission in Portland, Oregon.

Since the PIT-tag detection/diversion systems (Matthews et al. 1990, 1992; Achord et al. 1992, 1996b) were operational at Lower Granite, Little Goose, Lower Monumental, and McNary Dams throughout the migration season, most PIT-tagged fish were diverted back to the river below these dams. Therefore, to accurately portray timing at the dams for the various wild stocks of fish, we used first-time detections at each dam and adjusted these detections daily for spill. The following equation was used to adjust daily detections for individual streams and combined populations at each dam:

$$\frac{\text{number detected}}{\text{average daily powerhouse flow}} = \frac{x}{\text{average daily flow spilled}}$$

where x was rounded to the nearest whole number and added to the number detected to produce an adjusted number of PIT-tagged fish passing each dam daily for individual or combined populations[1].

From 4 April to 22 September 1997, an adjusted total of 249 wild fish PIT tagged in Idaho were detected (first-time) at the six dams (Table 4 and Appendix Tables 3A-5B).

[1] Due to rounding, total adjusted numbers for daily detections of fish from combined streams in Appendix Tables 7-10 may not add up to the total adjusted detections for individual streams in Table 4.

Table 4. Summary of first-time detections and detections adjusted for spill of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at four dams from April to September 1997.

	Detections											
	Lower Granite Dam			Little Goose Dam			Lower Monumental Dam			McNary Dam		
		Adjusted			Adjusted			Adjusted			Adjusted	
Stream	Unadjusted	N	%	Unadjusted	N	%	Unadjusted	N	%	Unadjusted	N	%
S. Fork Salmon River	36	53	7.6	13	21	3.0	16	26	3.7	4	12	1.7
Secesh River	34	43	16.5	9	14	5.4	4	6	2.3	3	8	3.1
Lake Creek[a]	22	28	7.0	15	22	5.5	5	8	2.0	3	7	1.7
Totals or averages	92	124	9.1	37	57	4.2	25	40	2.9	10	27	2.0

[a] One additional fish from this stream had a first-time detection at John Day Dam.

Based upon the number of PIT-tagged parr released in 1996 (1,360), the overall average adjusted percentage of first-time detections at the six dams was 18.3%, with averages of 9.1, 4.2, 2.9, 2.0, 0.1, and 0.0% at Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams, respectively. The adjusted proportions of total fish detected at the six dams were 49.8, 22.9, 16.1, 10.8, 0.4, and 0.0% for Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams, respectively. The overall detection rates at the four collector dams varied by stream of origin (Fig. 2 and Table 4), ranging from 16.0% for South Fork of the Salmon River fish to 27.3% for Secesh River fish.

At release, the average fork length for all fish was 67 mm. However, for fish detected the following spring at the dams, the average fork length at release was 69 mm. A chi-square comparison of length distributions showed these lengths were significantly different ($P = 0.0001$). The release length distribution of detected fish was significantly different than the length distribution of all released fish ($P < 0.002$) (Fig. 3). The largest difference was that there were too few fish detected that were 59 mm or smaller, and too many fish detected in the greater than 69-mm groups.

We also found a significant difference in fork lengths at time of release between fish that migrated through the dams in April and fish that migrated in May ($P < 0.0001$), but no significant differences in fork lengths were observed between fish that migrated through the dams in April and after May ($P > 0.05$). Fish migrating through the dams in April were on average 5 mm larger when released than fish migrating in May and 2 mm larger than fish migrating after May. However, there was a small sample size for wild fish detections after May.

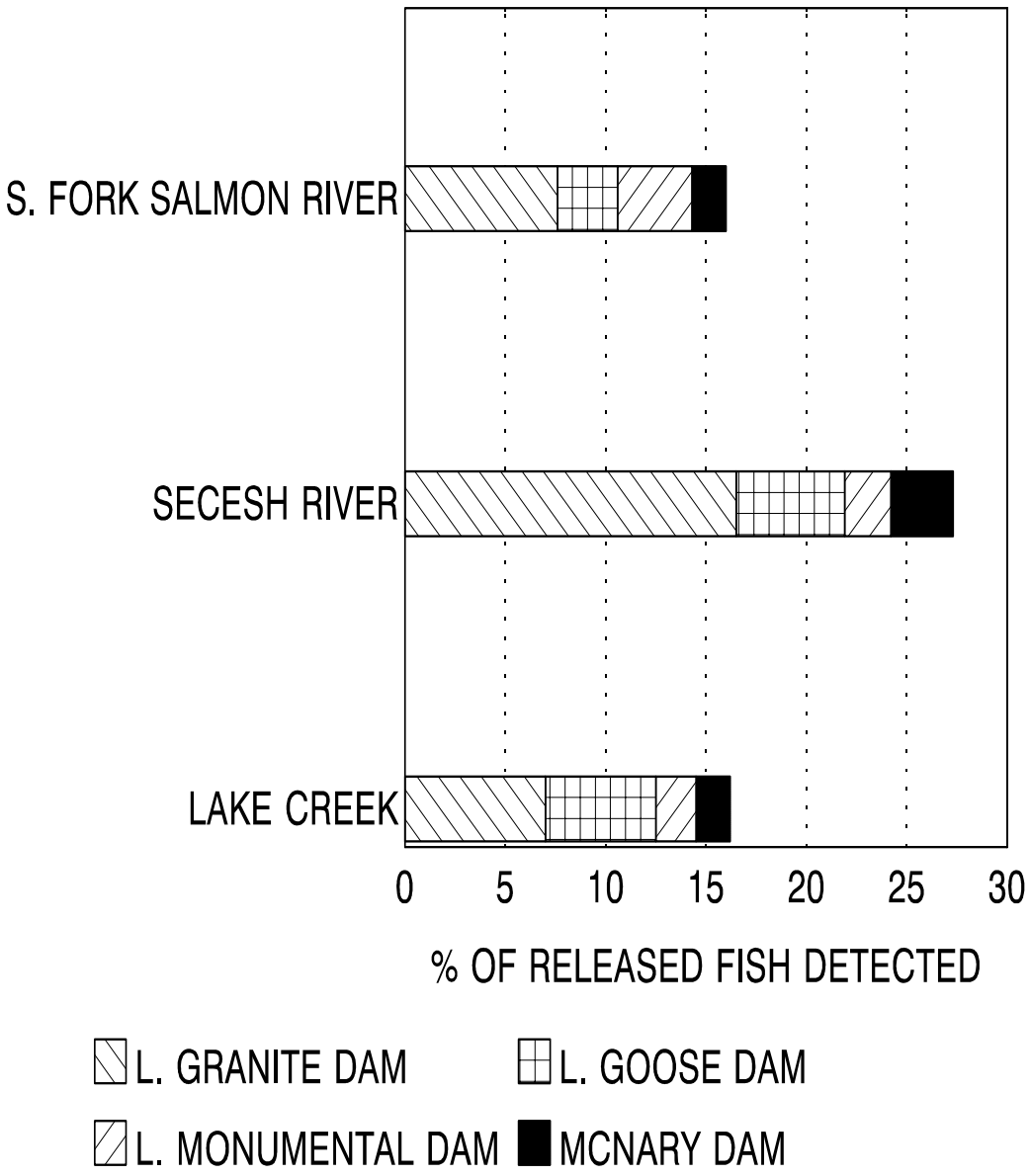

Figure 2. Percent (adjusted for spill) of PIT-tagged wild spring/summer chinook salmon smolts detected at Lower Granite, Little Goose, Lower Monumental, and McNary Dams in 1997.

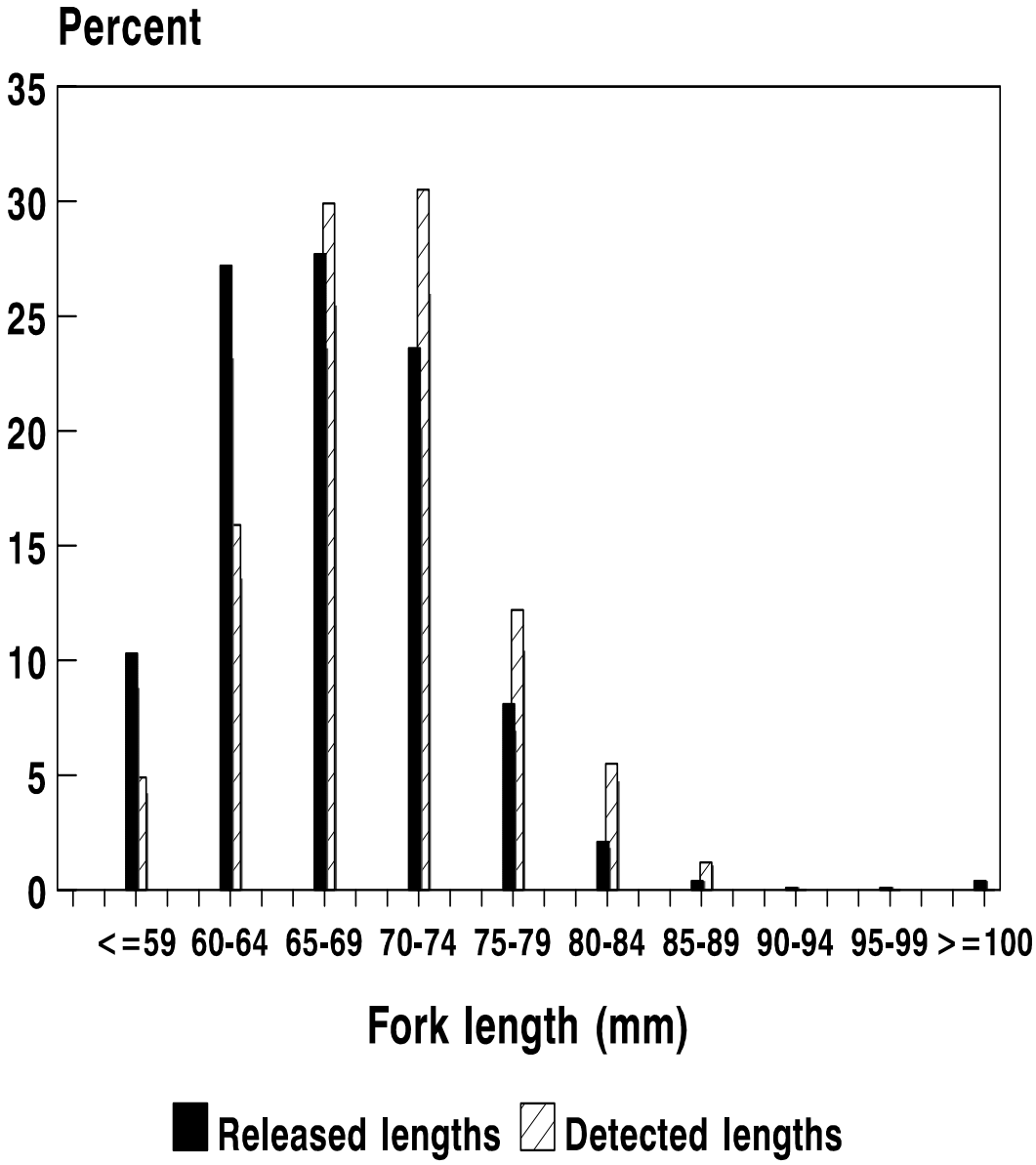

Figure 3. Percent, by fork length increments, of PIT-tagged wild spring/summer chinook salmon parr released in Idaho streams in 1996 and percent of fish detected for these length increments at Lower Granite, Little Goose, Lower Monumental, McNary, and John Day Dams in spring and summer 1997.

These data suggest that fish size may be an important factor influencing migration timing or overwintering location with respect to proximity to the first dam.

MIGRATION TIMING AT DAMS

Migration timing at dams was calculated by totaling the adjusted number of detections in 3-day intervals and dividing by the total adjusted detections during the season. This method was applied to detection data for fish from individual and combined streams. Timing of smolt migrations from individual streams was calculated at Lower Granite Dam (Fig. 4), while migration timing for smolts from all Idaho streams combined was calculated at all four collector dams (Fig. 5).

Summer-tagged fish from five of the six streams of Idaho and Oregon (except Catherine Creek) had early timings at Lower Granite Dam (Fig. 4 and Table 5). Over 50% of the fish from these streams passed the dam in April, and all peak passage dates for fish from these streams occurred in April (Appendix Tables 3A, 4A, 5A, and Fig. 4). Summer-tagged fish from Catherine Creek were at least 2 weeks later at the dam, with 50% passing in mid-May and all peak passage dates in May.

We did not perform statistical comparisons of passage distributions for wild chinook salmon smolts from the three streams in Idaho at Lower Granite Dam in 1996 because of low numbers of fish detected from these streams.

Timing of smolts from individual streams in Idaho is not presented here for Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams. See Appendix Tables 3A-5B for this information.

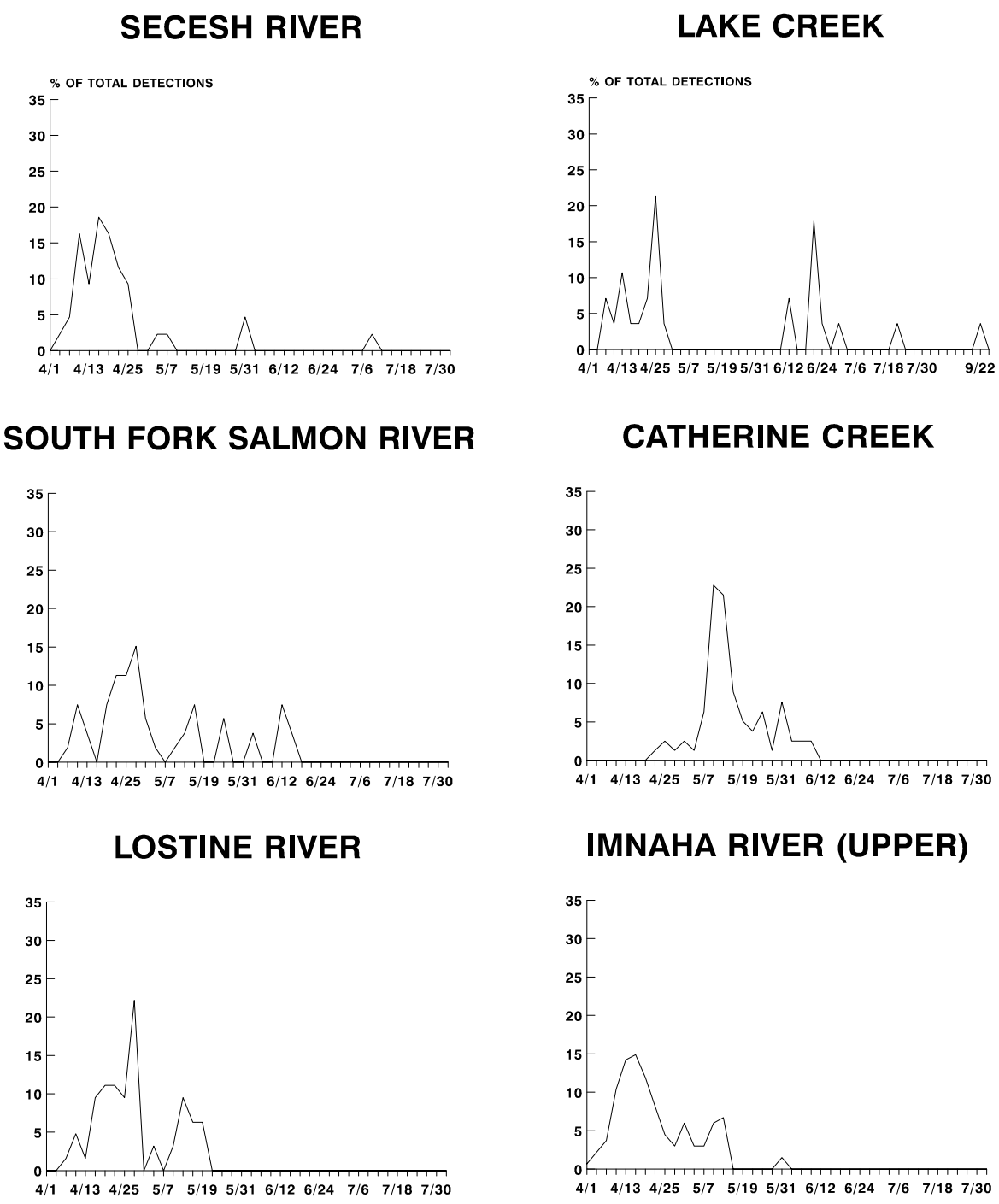

Figure 4. The migration timing (adjusted for spill) at Lower Granite Dam in 1997 of wild spring/summer chinook salmon smolts from individual streams in Idaho and Oregon PIT tagged during late summer 1996.

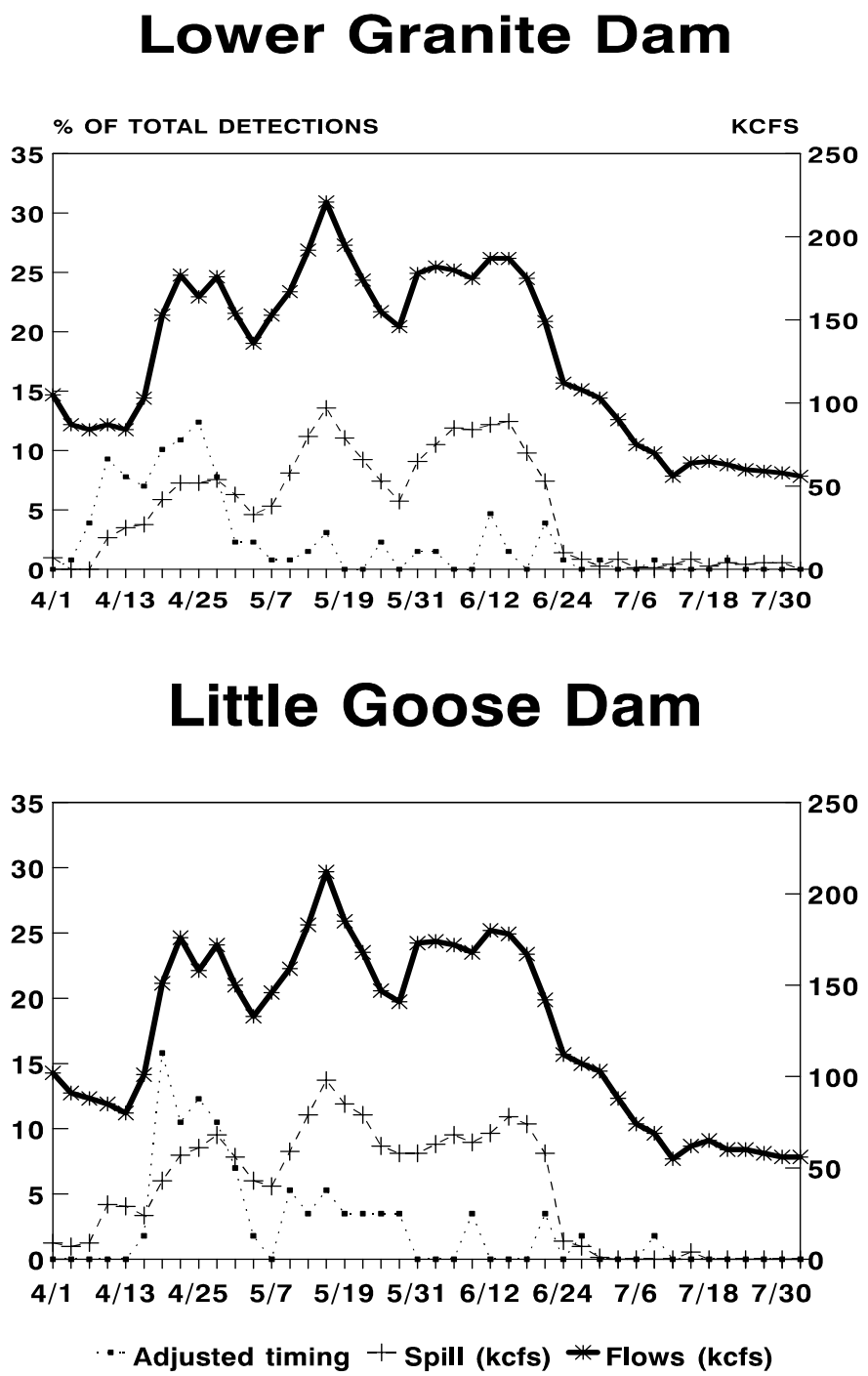

Figure 5. The overall migration timing of PIT-tagged wild spring/summer chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary Dams in 1997, with associated river spill and flows at these dams. Data represent detections from three Idaho streams combined by 3-day intervals and average river spill and flows at the dams over the same time periods.

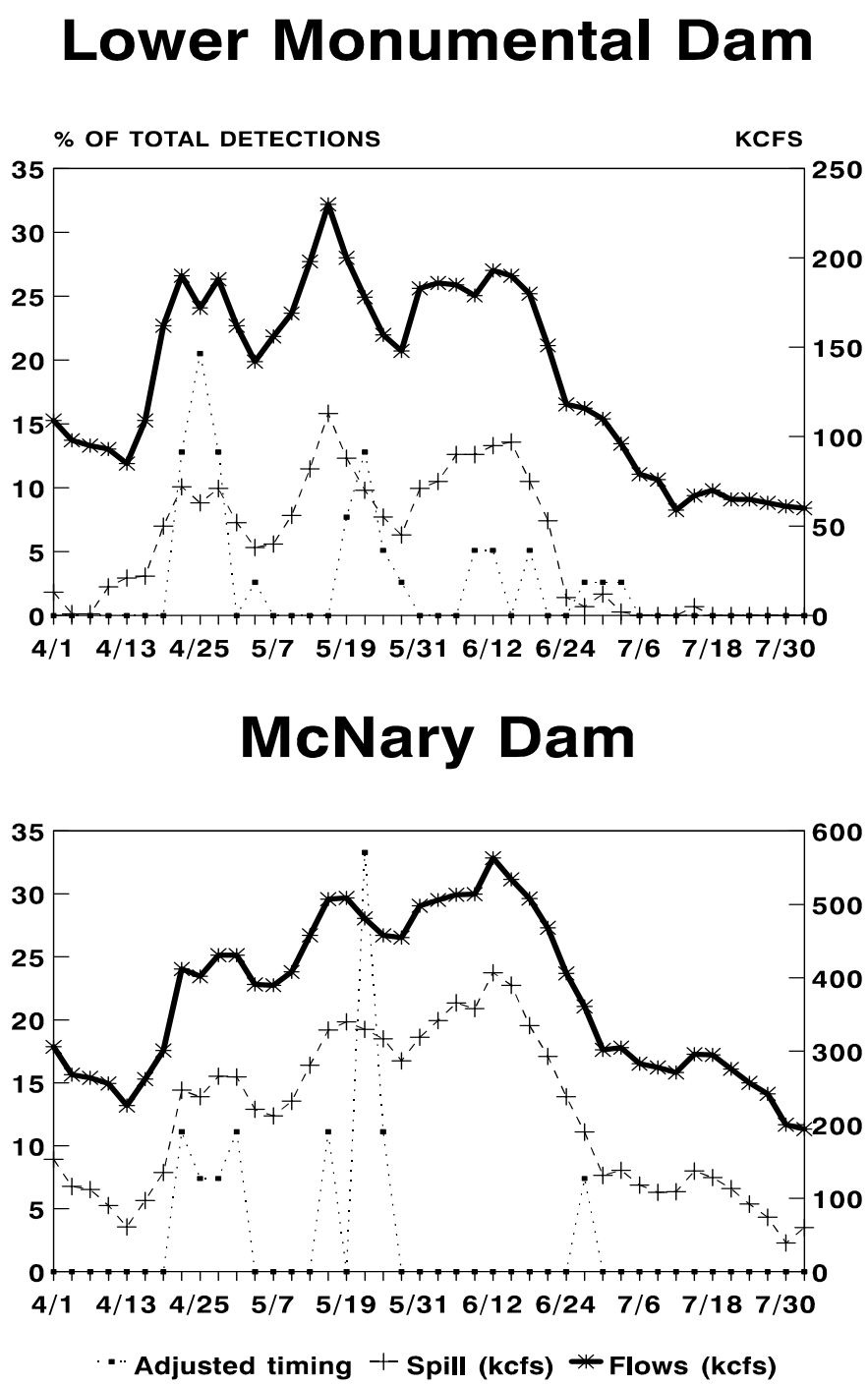

Figure 5. Continued.

Table 5. Historical and 1997 passage dates at Lower Granite Dam for PIT-tagged wild spring/summer chinook salmon smolts from streams in Idaho and Oregon.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	Range
		Bear Valley Creek		
1990	19 April	05 May	31 May	11 April - 18 July
1991	03 May	20 May	12 June	18 April - 23 June
1992	15 April	02 May	24 May	07 April - 28 June
1993	29 April	16 May	22 June	22 April - 27 July
1994	22 April	06 May	29 May	16 April - 15 July
1995	28 April	18 May	12 June	13 April - 20 July
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------
		Elk Creek		
1990[a]	----------	----------	----------	----------
1991	03 May	20 May	16 June	25 April - 24 June
1992	11 April	30 April	28 May	05 April - 17 July
1993	02 May	16 May	11 June	21 April - 26 June
1994	23 April	04 May	21 May	18 April - 09 July
1995	18 April	11 May	05 June	10 April - 09 July
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------
		Sulphur Creek		
1990	18 April	30 April	31 May	11 April - 27 June
1991[b]	----------	----------	----------	----------
1992	16 April	03 May	23 May	10 April - 01 June
1993	28 April	16 May	12 June	24 April - 28 June
1994[b]	----------	----------	----------	----------
1995	02 May	23 May	09 June	11 April - 09 July
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------

Table 5. Continued.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	Range
		Cape Horn Creek		
1990[b]	----------	----------	----------	----------
1991	24 April	16 May	28 May	19 April - 06 June
1992	12 April	28 April	30 May	10 April - 01 June
1993	08 May	19 May	26 June	05 May - 01 July
1994[b]	----------	----------	----------	----------
1995	29 April	14 May	19 June	14 April - 28 July
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------
		Marsh Creek		
1990	17 April	29 April	31 May	09 April - 01 July
1991	26 April	20 May	09 June	17 April - 18 June
1992	17 April	07 May	02 June	10 April - 13 July
1993	29 April	15 May	27 May	24 April - 10 August
1994	23 April	04 May	18 May	16 April - 08 August
1995	17 April	09 May	24 May	11 April - 08 July
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------
		Valley Creek		
1989	24 April	14 May	12 June	09 April - 17 June
1990	16 April	08 May	05 June	12 April - 29 June
1991	11 May	20 May	20 June	21 April - 13 July
1992	15 April	30 April	27 May	13 April - 04 June
1993	30 April	16 May	02 June	24 April - 06 June
1994	24 April	04 May	03 June	22 April - 09 June
1995	04 May	02 June	08 July	22 April - 18 July
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------

Table 5. Continued.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	Range
		Camas Creek		
1993	03 May	16 May	27 May	24 April - 24 June
1994	30 April	15 May	26 May	24 April - 11 July
1995	27 April	12 May	05 June	17 April - 11 June
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------
		Loon Creek		
1993	05 May	12 May	17 May	03 May - 25 June
1994	29 April	10 May	24 May	22 April - 07 June
1995	23 April	11 May	28 May	13 April - 07 June
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------
		East Fork Salmon River		
1989	22 April	03 May	18 May	07 April - 08 June
1990[b]	----------	----------	----------	----------
1991	22 April	09 May	26 May	16 April - 20 June
1992	13 April	21 April	16 May	10 April - 03 June
1993	25 April	06 May	18 May	22 April - 01 June
1994	22 April	28 April	17 May	20 April - 25 May
1995	14 April	28 April	10 May	11 April - 27 May
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------
		Herd Creek		
1992	14 April	20 April	10 May	13 April - 18 May
1993	26 April	30 April	18 May	26 April - 31 May
1994[a]	----------	----------	----------	----------
1995	18 April	03 May	14 May	11 April - 28 May
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------

Table 5. Continued.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	Range
		South Fork Salmon River		
1989	25 April	13 May	14 June	16 April - 20 June
1990[b]	----------	----------	----------	----------
1991	20 April	16 May	10 June	17 April - 13 July
1992	14 April	29 April	27 May	07 April - 27 July
1993	29 April	16 May	02 June	26 April - 28 June
1994	27 April	15 May	28 June	22 April - 09 July
1995	20 April	10 May	10 June	13 April - 13 July
1996	19 April	15 May	09 June	19 April - 03 July
1997	**13 April**	**28 April**	**12 June**	**07 April - 15 June**
		Big Creek (upper)		
1990	27 April	30 May	22 June	17 April - 18 July
1991	18 May	10 June	26 June	26 April - 01 July
1992	22 April	08 May	03 June	15 April - 26 June
1993	08 May	18 May	26 May	26 April - 15 June
1994	03 May	19 May	19 July	25 April - 30 August
1995	05 May	23 May	09 June	02 May - 26 June
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------
		Big Creek (lower)/Rush Creek		
1993	24 April	29 April	13 May	21 April - 16 May
1994	23 April	29 April	11 May	21 April - 15 June
1995	19 April	01 May	14 May	11 April - 05 June
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------

Table 5. Continued.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	Range
West Fork Chamberlain Creek				
1992[c]	15 April	26 April	03 June	12 April - 24 June
1993	28 April	15 May	23 June	23 April - 22 July
1994[c]	24 April	01 May	05 July	24 April - 04 September
1995[c]	16 April	09 May	20 June	12 April - 22 September
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------
Secesh River				
1989	20 April	27 April	09 June	09 April - 19 July
1990	14 April	22 April	07 June	10 April - 13 July
1991	20 April	27 April	14 June	13 April - 20 July
1992	13 April	29 April	04 June	05 April - 03 July
1993	26 April	16 May	16 June	22 April - 15 July
1994	22 April	26 April	11 July	21 April - 07 August
1995	14 April	01 May	24 May	10 April - 10 July
1996	14 April	25 April	29 May	12 April - 15 July
1997	**10 April**	**18 April**	**04 May**	**04 April - 11 July**
Lake Creek				
1989	23 April	02 May	16 June	12 April - 01 July
1990[b]	----------	----------	----------	----------
1991[b]	----------	----------	----------	----------
1992[b]	----------	----------	----------	----------
1993	23 April	09 May	22 June	22 April - 25 June
1994	21 April	28 April	19 May	20 April - 24 June
1995	17 April	10 May	10 June	14 April - 20 July
1996	15 April	21 April	19 May	15 April - 02 June
1997	**11 April**	**25 April**	**02 July**	**07 April - 22 September**

Table 5. Continued.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	Range
		Catherine Creek		
1991	01 May	14 May	08 June	17 April - 23 June
1992	16 April	01 May	21 May	09 April - 29 June
1993	06 May	18 May	05 June	29 April - 26 June
1994	25 April	11 May	20 May	13 April - 26 July
1995	01 May	19 May	09 June	26 April - 02 July
1996[e]	19 April	13 May	29 May	14 April - 14 June
1997	**08 May**	**14 May**	**01 June**	**24 April - 10 June**
		Grande Ronde River (upper)		
1989	12 May	06 June	19 June	27 April - 22 July
1990[b]	----------	----------	----------	----------
1991[b]	----------	----------	----------	----------
1992[b]	----------	----------	----------	----------
1993	05 May	16 May	25 May	23 April - 20 June
1994	28 April	23 May	07 July	23 April - 29 August
1995	27 April	29 May	12 June	12 April - 01 July
1996[d]	26 April	17 May	29 May	19 April - 06 June
1997[b]	----------	----------	----------	----------
		Imnaha River (lower)		
1989	11 April	30 April	11 May	04 April - 05 June
1990	10 April	18 April	09 May	05 April - 27 May
1991	20 April	01 May	13 May	14 April - 15 May
1992	10 April	21 April	03 May	06 April - 21 May
1993[b]	----------	----------	----------	----------
1994[b]	----------	----------	----------	----------
1995[b]	----------	----------	----------	----------
1996[b]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------

Table 5. Continued.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	Range
		Imnaha River (upper)		
1993	24 April	14 May	28 May	15 April - 23 June
1994	24 April	08 May	09 June	20 April - 11 August
1995	13 April	02 May	03 June	10 April - 07 July
1996	16 April	26 April	18 May	14 April - 12 June
1997	**11 April**	**19 April**	**11 May**	**03 April - 02 June**
		Lostine River		
1990[a]	----------	----------	----------	----------
1991	29 April	14 May	26 May	20 April - 09 July
1992	16 April	30 April	11 May	12 April - 02 June
1993	23 April	03 May	17 May	17 April - 01 June
1994	22 April	30 April	16 May	19 April - 07 June
1995	12 April	02 May	17 May	08 April - 09 June
1996	23 April	15 May	07 June	17 April - 19 June
1997	**17 April**	**28 April**	**16 May**	**09 April - 21 May**

[a] Insufficient numbers detected to estimate timing.
[b] No fish were tagged for this migration year.
[c] Includes fish from Chamberlain Creek.
[d] All fish tagged at traps in fall or spring for this migration year.
[e] Includes fish tagged from summer 1995 through spring 1996.

We combined all detections of wild fish from Idaho streams at each of the four collector dams and compared the timing at each dam with river flows during the same periods (Fig. 5). Overall, passage occurred between early April and late September at Lower Granite Dam, with the middle 80% passage from mid-April to mid-June (Table 6). The peak passage dates were 22 and 25 April, which coincided with high flows, but not peak flows, at the dam (Appendix Table 7). The middle 80% passage of wild fish occurred between late April and mid-June for Little Goose, Lower Monumental, and McNary Dams (Table 6). Peak passage periods for fish at Little Goose, Lower Monumental, and McNary Dams coincided with high river flows on various dates throughout April and May (Fig. 5 and Appendix Tables 8-10).

ENVIRONMENTAL INFORMATION

One goal of this study is to identify relationships between environmental factors where wild parr reside and subsequent migration timing of parr and smolts as they migrate through downstream traps and dams. From 1993 through 1996, NMFS worked with Pacific Northwest National Laboratories (PNNL) to obtain environmental data with funding through Bonneville Power Administration. In late fall 1996, PNNL relinquished all monitoring activities to NMFS.

In 1993, PNNL personnel conducted an extensive review of historical and present environmental information collected in Idaho study streams. In November and December 1993, they installed environmental monitoring systems at five sites: near Thomas Creek in the Middle Fork of the Salmon River, in Marsh and Valley Creeks, near Sawtooth Hatchery in the upper Salmon River, and in the Salmon River below its confluence with the Yankee Fork. Achord et al. (1995b) provided additional information about these stream monitors.

Table 6. Passage dates at Lower Granite, Little Goose, Lower Monumental, and McNary Dams for combined populations of PIT-tagged wild spring/summer chinook salmon smolts from three streams in Idaho in 1997.

	Passage periods at dams			
Site	10%	50%	90%	Range
Lower Granite Dam	11 Apr	25 Apr	13 Jun	04 Apr - 22 Sep
Little Goose Dam	21 Apr	30 Apr	10 Jun	18 Apr - 30 Aug
Lower Monumental Dam	24 Apr	20 May	19 Jun	23 Apr - 04 July
McNary Dam	24 Apr	22 May	27 May	24 Apr - 29 Jun

In April 1996, PNNL personnel moved the monitor from Yankee Fork to the Krassel U.S. Geological Survey (USGS) site on the South Fork of the Salmon River. We recommended this change because wild fish were only PIT tagged in the South Fork of the Salmon River drainage in 1995 and 1996. However, this monitor malfunctioned in fall 1996 and was subsequently covered by coarse granitic sand during flooding in mid-winter. We will continue to report the environmental information from monitoring sites to establish a yearly database for future analyses. Appendix Table 11 provides a summary of flow information at five USGS sites in the Salmon River drainage from August 1996 to July 1997. Appendix Tables 12-14 provide a summary of environmental information collected from three of the environmental monitoring sites from August 1996 to July 1997. Monitor malfunctions precluded the reporting of data from the other two sites. Environmental information collected at these sites is available on the Internet at http://bemdata.nwfsc.noaa.gov/baseline/intro.html.

ADULT RETURNS FROM 1989-1995 SMOLT MIGRATIONS

Although providing analyses of adult returns is not an objective of this study, there is considerable interest concerning the return of PIT-tagged adult wild spring/summer chinook salmon to the Snake River. Of the wild spring/summer chinook salmon PIT tagged and released for the 1989 through 1995 smolt migrations (under coordinator ID "SA"), 21 were detected as adults at the adult trap at Lower Granite Dam through 1997. Of the 21 adults, 12 were transported as smolts from Lower Granite Dam to below Bonneville Dam, 4 were transported as smolts from Little Goose Dam to below Bonneville Dam, 1 was detected and diverted to the river below Lower Monumental Dam, and 4 were never detected at any dam during previous smolt migrations.

DISCUSSION

Mortality rates associated with collection and tagging in 1996 were comparable to those in earlier years (Achord et al. 1992, 1994, 1995a, 1995b, 1996a, 1996b, 1997).

Few wild fish released in summer to the South Fork of the Salmon River were detected at the juvenile migrant fish trap on the South Fork of the Salmon River in either fall 1996 or spring 1997. Of the 29 summer-released, wild PIT-tagged fish monitored at this trap in the fall, two were detected the next spring at the dams. The one summer-released, wild PIT-tagged fish monitored at this trap during the spring was not detected at the dams. No survival comparisons can be made from these data due to the low numbers monitored at the trap and at the dams.

Length-distribution curves for data collected over the last 9 years showed that, generally, wild fish released and subsequently detected at dams are slightly larger than fish that are released but not detected. The reason for this slight difference in size is unknown. However, it appears that larger fish, tagged and released the previous summers, survived slightly better and/or were guided slightly better into the collection systems at the dams than smaller fish. Another consistent trend we have observed over the years is the difference in migration timing at dams with respect to size at tagging. Wild fish migrating in April were significantly larger at release than fish migrating in May. This consistent trend suggests that size is an important factor related to either the initiation of smoltification or other life-history dynamics that affect the migrational timing of wild fish.

Although the 10 to 90% passage dates for fish from the South Fork of the Salmon River and the Secesh River have varied over the years (1989-1997) at Lower Granite Dam, certain patterns have emerged (Table 5). In most years from 1989 to 1996, half of the fish from the Secesh River passed by 1 May, while half of the wild fish from the South Fork of the Salmon

River had passed the dam by mid-May. Secesh River fish consistently exhibited a much more compressed 10 to 50% passage time at the dam than the South Fork of the Salmon River fish. However, Secesh River fish showed a much more protracted 50 to 90% passage time than South Fork of the Salmon River fish at the dam. In 1997, fish from both of these streams displayed early and compressed timing at the dam for the 10 to 50% passage, and Secesh River fish also showed a compressed 50 to 90% passage (compared to previous years) while South Fork Salmon River fish displayed a protracted 50 to 90% passage.

In 1997, the overall detection rate (adjusted) of wild fish from the South Fork of the Salmon River drainage was higher than the previous 4 years at the four collector dams (Achord et al. 1995a, 1995b, 1996a, and 1997). Overall, 1997 was the highest flow year since wild fish have been PIT-tagged in the Snake River Basin. It appears wild fish survival may be higher in high snow-pack or water years, or perhaps the higher detection rates may partially be a reflection of higher adjusted numbers due to increased spill.

In 1997, peak detections of wild fish (Idaho and Oregon) at Lower Granite Dam coincided with high, but variable flows in April. High flows continued throughout most of the migration season, and almost 90% of the wild fish had moved through the dam by mid-May. In 1996, peak detections of wild fish at Lower Granite Dam did not coincide well with peak flows before mid-May but did after mid-May (Fig. 6). Before about 9 May in 1996, as observed in all previous migration years at Lower Granite Dam from 1989 to 1995, peak detections of wild spring/summer chinook salmon smolts from Idaho and Oregon were highly variable and generally independent of river flows; however, in every year (including 1997), peak detections of wild fish from 9 to 31 May coincided with periods of peak flows at the dam (Fig. 6).

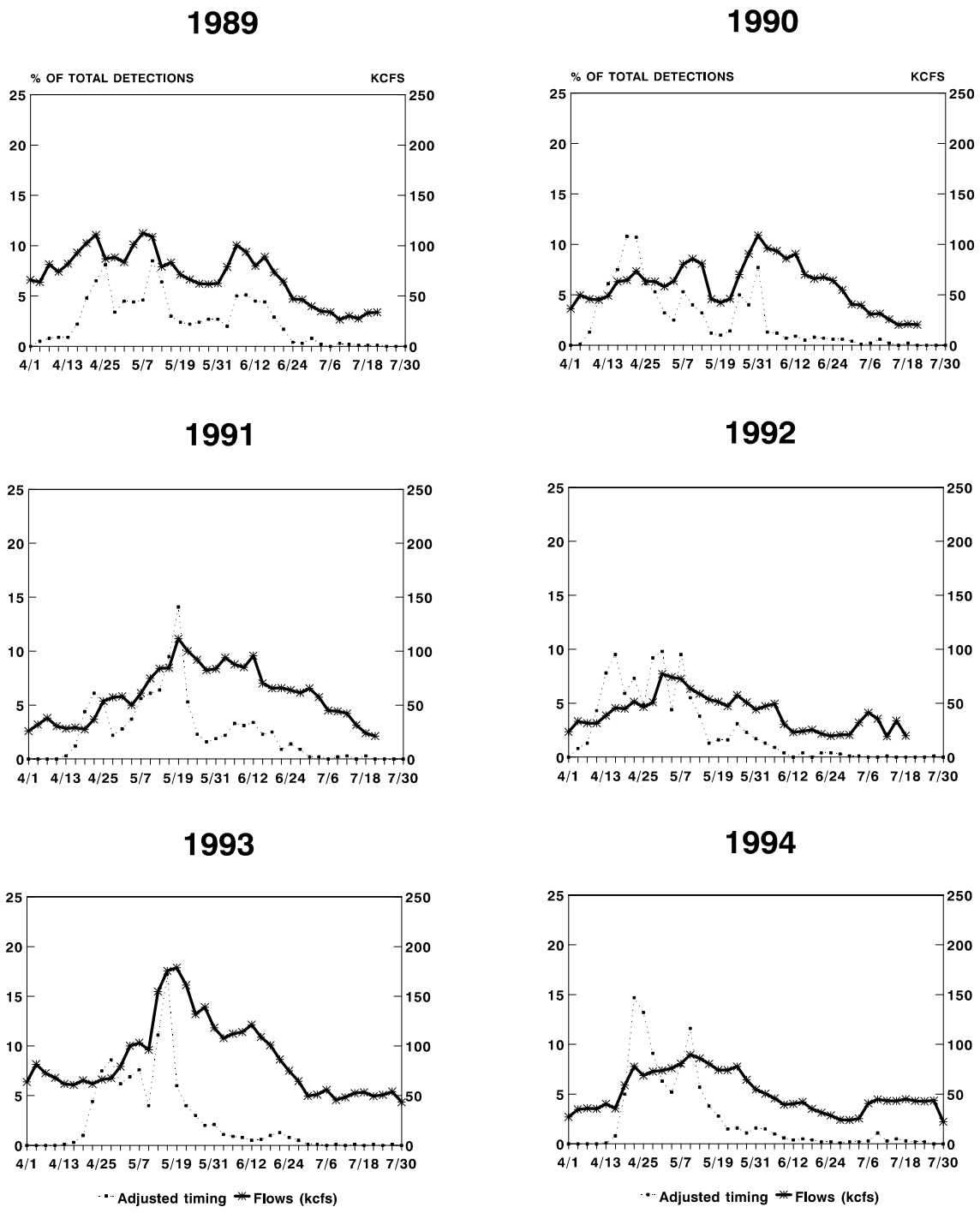

Figure 6. The historical perspective on migration timing (adjusted in spill years) of wild spring/summer chinook salmon smolts at Lower Granite Dam 1989-1997, with associated river flows at the dam. Data represent PIT-tag detections from Idaho and Oregon streams combined by 3-day intervals and average river flows at the dam over the same time periods.

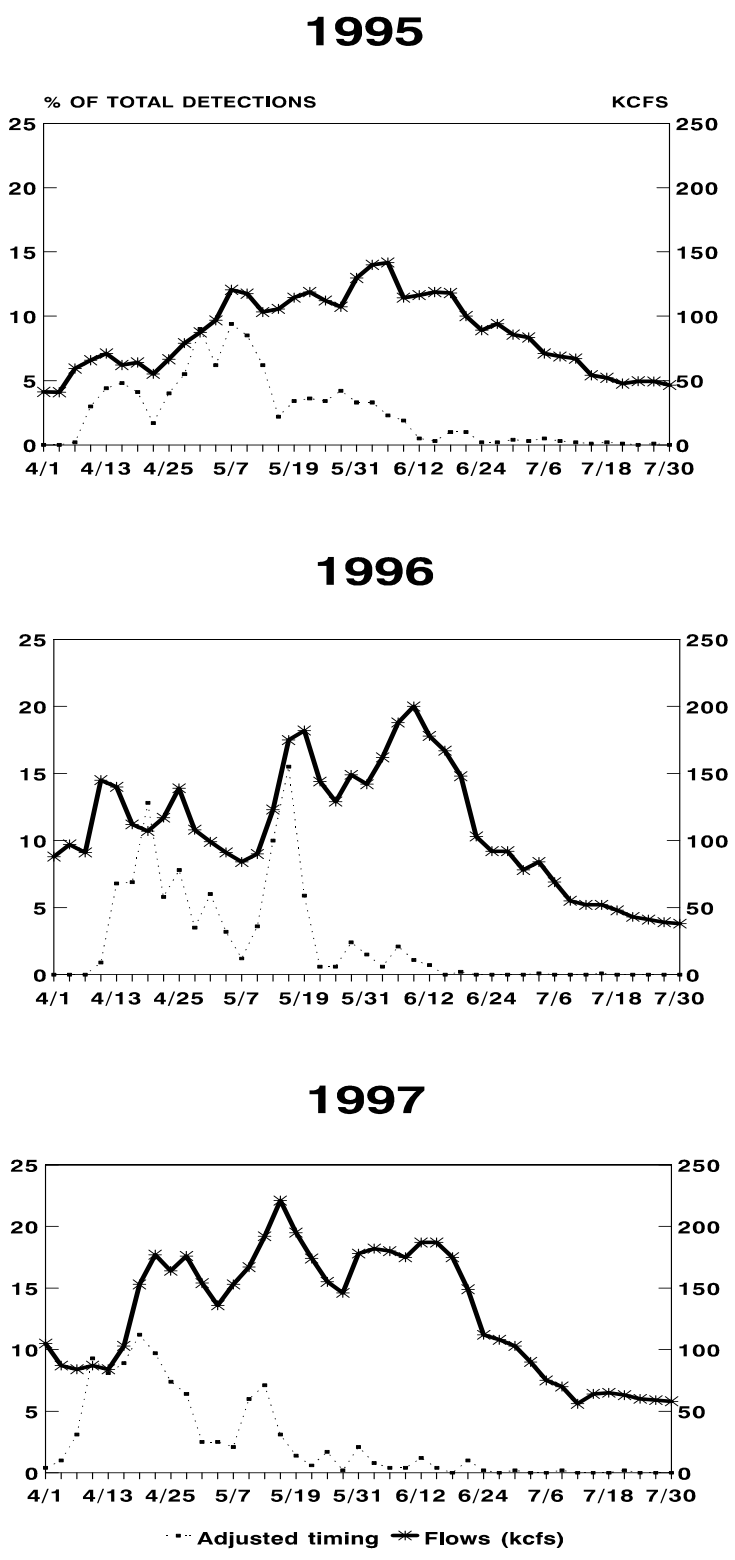

Figure 6. Continued.

In both 1995 and 1996, the highest flows at the dam occurred in June, well after 90% of the wild fish migration had passed the dam. Raymond (1979) showed that peaks of migration for the

composite population of spring and summer chinook salmon smolts (mostly wild) passing Ice Harbor Dam from 1964 to 1969 preceded the periods of maximum river discharge in most years. During these years, fish passage peaked between 26 April and 13 May. With respect to river flows, our observations matched those of Raymond for wild fish migrating before mid-May.

Annual overall climatic variation is emerging as an important factor controlling the overall migrational timing of wild spring/summer chinook salmon smolts at Lower Granite Dam. Figures 6 and 7 provide another perspective on timing of combined populations (Idaho and Oregon) of wild spring/summer chinook salmon smolts from 1989 through 1997 at Lower Granite Dam. In the warm years of 1990, 1992, and 1994, 50% of all wild fish had passed this dam from 29 April to 4 May, and 90% had passed by the end of May. In the cold years of 1989, 1991, and 1993, 50% of all wild fish had not passed the dam until mid-May, while 90% had not passed until mid-June (except in 1993, when high flows moved 90% through the dam by the end of May). Within these 6 years, we saw a consistent 2-week shift in timing of wild fish at this dam between relatively warm and relatively cold years. In 1995, intermediate weather conditions prevailed in late winter and early spring (compared to the previous 6 years), and we observed intermediate passage times of 9 May and 5 June for the 50 and 90% passage dates, respectively, for these combined wild populations (Fig. 7). The overall passage timing of wild fish in 1996 and 1997 at the dam should not be compared to previous years, since 91 and 73.5% (respectively) of wild fish detections at Lower Granite Dam were from Oregon streams, whereas in all previous years, less than 50% of wild fish detected were from Oregon streams.

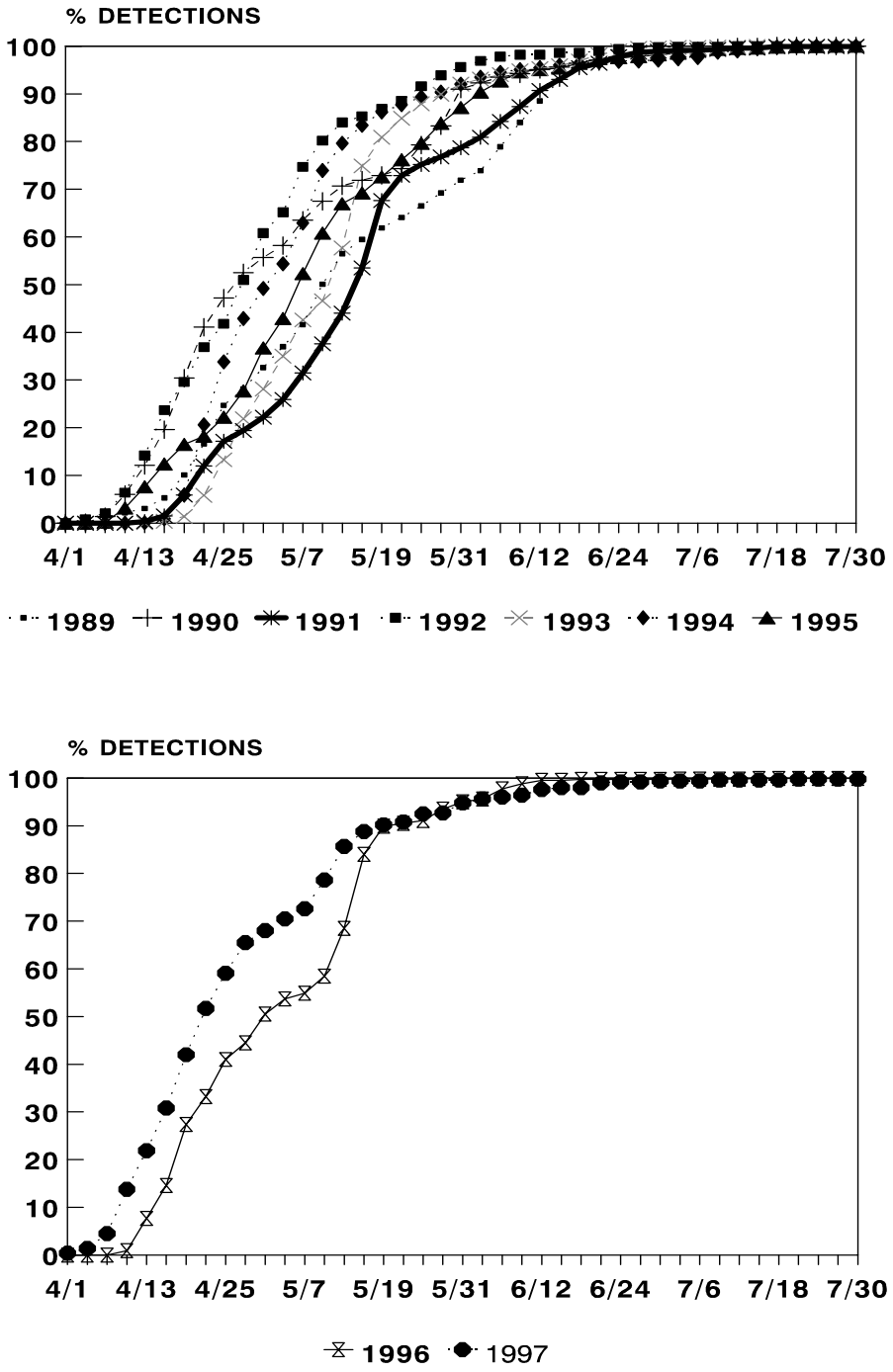

Figure 7. Cumulative percentages of total detections (adjusted in spill years) of PIT-tagged wild spring/summer chinook salmon smolts detected at Lower Granite Dam, 1989-1997. Data represent PIT-tag detections from Idaho and Oregon streams combined by 3-day intervals.

In addition, fish from Oregon streams and from streams of the South Fork of the Salmon River drainage are known to have earlier timings at the dam than those from other Idaho streams.

Peak detections of wild fish at the collector dams below Lower Granite Dam coincided well with peak river flows in 1992 and 1993. We were unable to determine whether the increased river flows moved these groups of fish through the reservoirs or were simply coincidental with their arrival at the dams. Since peak detections at these dams have consistently occurred almost simultaneously with increased flow, it is likely that fish were already near the dams and were moved through them rapidly by the increased flow. However, this apparently did not occur in 1994. Peak detections at the lower collector dams did not coincide well with peak flows. In fact, peak flows at these dams coincided with significant decreases in wild fish detections, even though detections were adjusted for spill. This was the first year there was considerable spill below powerhouse capacity at these lower collector dams. Perhaps this spill (beginning 10 May) moved a larger proportion of these wild fish through these dams during peak flows, thereby decreasing the numbers detected through the bypass systems. In 1995, peak detections of wild fish at these dams coincided with medium to high flows prior to peak flows. In 1996 and 1997, peak detections of wild fish at these dams coincided with high flows at various times throughout April, May, and June.

ACKNOWLEDGMENTS

We thank Neil N. Paasch, Kenneth W. McIntyre, Douglas M. Marsh, and Ron A. Marr for their excellent assistance in collecting and PIT tagging fish for this study.

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APPENDIX TABLES

Appendix Table 1. Summary of tagging dates, number collected, tagged, released, and minimum, maximum, and average lengths and weights of wild chinook salmon parr, PIT tagged in various Idaho streams in 1996.

Stream	Tagging dates	Number collected	Number tagged	Number released	Length (mm) Range	Length (mm) Average	Weight (g) Range	Weight (g) Average
S. F. Salmon River	20 Aug - 22 Aug	780	700	700	51 - 107	64	1.7 - 17.0	3.6
Secesh River	26 Aug - 28 Aug	267	260	260	56 - 125	70	2.5 - 23.7	5.1
Lake Creek	29 Aug - 30 Aug	408	401	400	60 - 117	71	2.5 - 24.3	5.0
Totals or averages	20 Aug - 30 Aug	1,455	1,360	1,360	51 - 125	67	1.7 - 24.3	4.4

Appendix Table 2. A summary of observed total mortality for PIT tagged wild chinook salmon parr collected from Idaho streams during August 1996.

Stream	Collection method	Number collected	Number tagged	Number rejected	Percent rejected (%)	Observed total mortality	
						Mortality	(%)
S. F. Salmon River	Shock	780	700	78	10.0	2	0.3
Secesh River	Shock	267	260	5	1.9	2	0.7
Lake Creek	Shock	408	401	4	1.0	4	1.0
Totals		1,455	1,361	87	6.0	8	0.5

Appendix Table 3A. Detections of PIT-tagged smolts by date at three Snake River dams for wild chinook salmon from the South Fork of the Salmon River, 1997. Numbers in parentheses are first detections at the dams that have been adjusted for spill.

Tagging site: S. F. Salmon River
Release site: S. F. Salmon River
Release river kilometer(s) above Lower Granite Dam: 457 - 466

Release date: 20 - 22 Aug 1996
Number released: 700

	Lower Granite	Little Goose		Lower Monumental		
Detection date	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
07 Apr	1					
10 Apr	1					
11 Apr	2 (3)					
13 Apr	1					
14 Apr	1					
18 Apr		1			1	
20 Apr			2		1	
21 Apr	3 (4)	1				
22 Apr	4 (6)		2			
24 Apr			1			1
25 Apr	2 (3)	1				
26 Apr		1 (2)		3 (5)		

Appendix Table 3A. Continued.

Detection date	Lower Granite	Little Goose		Lower Monumental		
	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
27 Apr	2 (3)			1 (2)		
28 Apr	3 (4)		1		1	
29 Apr	2 (3)					
30 Apr	1	2 (3)	4	1 (2)		
01 May	1 (2)	1 (2)			1	3
02 May	1				2	
04 May	1			1		
06 May					1	
09 May					1	
10 May	1					
12 May		1 (2)				
13 May					1	
14 May	1 (2)	1 (2)				
16 May	1 (2)					
17 May			1			
18 May	1 (2)	1 (2)				

Appendix Table 3A. Continued.

Detection date	Lower Granite	Little Goose		Lower Monumental		
	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
19 May						1
20 May				2 (3)		
21 May		1 (2)				
22 May					1	
24 May				2 (3)		
26 May	1 (2)			1 (2)		
27 May	1	1 (2)				
30 May				1		
04 Jun	1 (2)					
09 Jun				1 (2)		
10 Jun			1			
12 Jun	1 (2)					
13 Jun	1 (2)					
14 Jun				1 (2)		
15 Jun	1 (2)					
19 Jun				1 (2)		

Appendix Table 3A. Continued.

	Lower Granite	Little Goose		Lower Monumental		
Detection date	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
27 Jun		1			1	
29 Jun					1	
30 Jun				1		
Total	36 (53)	13 (21)	12	16 (26)	12	5

Appendix Table 3B. Detections of PIT-tagged smolts by date at three Columbia River dams for wild chinook salmon from the South Fork of the Salmon River, 1997. Numbers in parentheses are first detections at the dams that have been adjusted for spill.

	McNary				John Day					Bonneville					
		Previous detections				Previous detections					Previous detections				
Detection date	First detections	1 dam	2 dams	3 dams	First detection	1 dam	2 dams	3 dams	4 dams	First detection	1 dam	2 dams	3 dams	4 dams	5 dams
28 Apr												1			
30 Apr		1	1												
07 May		1													
08 May		1													
12 May												1			
18 May	1 (3)														
20 May											1				
22 May	1 (3)														
23 May	1 (3)										1				
27 May	1 (3)														
07 Jun											1				
24 Jun											1				
Totals	4 (12)	3	1								4	2			

Appendix Table 4A. Detections of PIT-tagged smolts by date at three Snake River dams for wild chinook salmon from the Secesh River, 1997. Numbers in parentheses are first detections at the dams that have been adjusted for spill.

Tagging site: Secesh River
Release site: Secesh River
Release river kilometer(s) above Lower Granite Dam: 430 - 442

Release date: 26 - 28 Aug 1996
Number released: 260

	Lower Granite	Little Goose		Lower Monumental		
Detection date	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
04 Apr	1					
08 Apr	1					
09 Apr	1					
10 Apr	4 (5)					
11 Apr	1					
12 Apr	1					
13 Apr	1					
15 Apr	2 (3)					
16 Apr	1					
17 Apr	2 (3)					
18 Apr	3 (4)		1			
19 Apr	3 (4)		1			

Appendix Table 4A. Continued.

	Lower Granite	Little Goose		Lower Monumental		
Detection date	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
21 Apr	2 (3)	3 (4)	5		1	
22 Apr	2 (3)	1	1		1	
23 Apr	1	2 (3)			1	
24 Apr	1			2 (3)	4	
25 Apr	3 (4)			1		
26 Apr		1 (2)	1			
28 Apr				1 (2)	1	1
29 Apr		1 (2)				
30 Apr			1			
01 May						1
04 May	1					
09 May	1				1	
12 May			1			
15 May			1			
31 May	1 (2)					
03 Jun			1			

Appendix Table 4A. Continued.

	Lower Granite	Little Goose		Lower Monumental		
Detection date	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
10 Jun		1 (2)				
11 Jul	1					
Totals	34 (43)	9 (14)	13	4 (6)	9	2

Appendix Table 4B. Detections of PIT-tagged smolts by date at three Columbia River dams for wild chinook salmon from the Secesh River, 1997. Numbers in parentheses are first detections at the dams that have been adjusted for spill.

	McNary				John Day					Bonneville					
		Previous detections				Previous detections					Previous detections				
Detection date	First detections	1 dam	2 dams	3 dams	First detection	1 dam	2 dams	3 dams	4 dams	First detection	1 dam	2 dams	3 dams	4 dams	5 dams
24 Apr	1 (3)														
26 Apr	1 (2)		1				1								
01 May	1 (3)														
02 May												1			
19 May			1												
Totals	3 (8)		2				1					1			

Appendix Table 5A. Detections of PIT-tagged smolts by date at three Snake River dams for wild chinook salmon from Lake Creek, 1997. Numbers in parentheses are first detections at the dams that have been adjusted for spill.

Tagging site: Lake Creek
Release site: Lake Creek
Release river kilometer(s) above Lower Granite Dam: 451 - 454

Release date: 29 - 30 Aug 1996
Number released: 400

	Lower Granite	Little Goose		Lower Monumental		
Detection date	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
07 Apr	1					
09 Apr	1					
11 Apr	1					
14 Apr	2 (3)					
18 Apr	1					
19 Apr		1				
20 Apr		1				1
21 Apr	1	1				
22 Apr	1	1				1
23 Apr				1 (2)		1
24 Apr	1					
25 Apr	3 (4)					

Appendix Table 5A. Continued.

Detection date	Lower Granite	Little Goose		Lower Monumental		
	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
26 Apr	1 (2)	1 (2)	1			
28 Apr	1			1 (2)	1	1
29 Apr		1 (2)				
30 Apr					1	
01 May					1	
02 May		1 (2)			1	
04 May					1	
06 May		1				
09 May					1	
10 May					1	
11 May		1				
17 May		1 (2)				
23 May		1 (2)		1 (2)		
24 May					1	
28 May		1 (2)				
12 Jun	1 (2)					

Appendix Table 5A. Continued.

Detection date	Lower Granite	Little Goose		Lower Monumental		
	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
21 Jun	2 (3)	1 (2)				
22 Jun	1 (2)					
24 Jun					1	
25 Jun			1			
26 Jun	1					
28 Jun						1
29 Jun				1		
02 Jul	1					
04 Jul				1		
09 Jul			1			
10 Jul		1				
21 Jul			1			
23 Jul	1					
27 Jul						1

Appendix Table 5A. Continued.

	Lower Granite	Little Goose		Lower Monumental		
Detection date	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
30 Aug		1				
22 Sep	1					
Totals	22 (28)	15 (22)	4	5 (8)	12	3

Appendix Table 5B. Detections of PIT-tagged smolts by date at three Columbia River dams for wild chinook salmon from Lake Creek, 1997. Numbers in parentheses are first detections at the dams that have been adjusted for spill.

	McNary				John Day					Bonneville					
		Previous detections				Previous detections					Previous detections				
Detection date	First detections	1 dam	2 dams	3 dams	First detection	1 dam	2 dams	3 dams	4 dams	First detection	1 dam	2 dams	3 dams	4 dams	5 dams
28 Apr	1 (2)														
08 May												1			
23 May	1 (3)														
23 Jun					1										
29 Jun	1 (2)														
03 Jul											1				
28 Sep		1													
Totals	3 (7)	1			1						1	1			

Appendix Table 6. A summary of the tagging dates, start tagging times and temperatures (°C), release dates, times, and temperatures, method of capture, distance (in kilometers) from the stream's mouth to the release point, number released, unadjusted number detected, and unadjusted percent detected for each tag group at six downstream dams during 1997.

Stream	Tag group	Tagging date	Tagging time	Release date	Release time	Tagging temperature	Release temperature	Capture method	Release river km	Number released	Number detected	Percent detected
S. F. Salmon River	SA96233.SF1	20 Aug	08:39	21 Aug	07:45	8.0	8.5	Shock	112	124	11	8.9
	SA96233.SF2	20 Aug	10:08	20 Aug	12:30	8.5	9.5	Shock	112	106	17	16.0
	SA96233.SF3	20 Aug	11:17	20 Aug	13:30	9.0	11.0	Shock	113	144	14	9.7
	SA96234.SF1	21 Aug	08:12	21 Aug	12:00	7.5	10.0	Shock	117	238	23	9.7
	SA96235.SF1	22 Aug	09:33	22 Aug	11:45	6.5	8.0	Shock	121	88	4	4.5
Secesh River	SA96239.SE1	26 Aug	09:47	27 Aug	08:15	8.5	11.0	Shock	25	97	20	20.6
	SA96240.SE1	27 Aug	10:41	27 Aug	14:00	11.5	13.0	Shock	28	144	27	18.8
	SA96241.SE1	28 Aug	09:13	28 Aug	13:00	9.5	11.0	Shock	37	19	3	15.8
Lake Creek	SA96242.LC1	29 Aug	08:38	30 Aug	13:30	7.5	11.5	Shock	3	262	27	10.3
	SA96243.LC1	30 Aug	10:16	30 Aug	14:00	8.5	12.0	Shock	1	138	19	13.8

Appendix Table 7. Daily detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Lower Granite Dam during 1997, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam. Adjusted numbers detected are calculated during spill.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
01 Apr	112.4	11.7	8.3	0	0
02 Apr	103.8	8.3	8.3	0	0
03 Apr	97.7	0.0	8.2	0	0
04 Apr	95.2	0.0	7.8	1	1
05 Apr	85.3	0.0	7.6	0	0
06 Apr	79.9	0.0	7.6	0	0
07 Apr	82.7	0.0	7.7	2	2
08 Apr	87.3	0.0	7.8	1	1
09 Apr	83.1	0.0	7.8	2	2
10 Apr	89.1	11.2	7.9	5	6
11 Apr	88.5	22.4	8.0	4	5
12 Apr	82.0	22.7	8.0	1	1
13 Apr	81.8	22.3	7.6	2	3
14 Apr	82.9	23.6	7.5	3	4
15 Apr	88.2	28.0	7.8	2	3
16 Apr	92.7	25.2	7.8	1	1
17 Apr	105.5	28.1	8.1	2	3
18 Apr	110.8	28.2	8.4	4	5
19 Apr	122.6	28.2	8.4	3	4
20 Apr	156.5	42.4	8.1	0	0
21 Apr	181.0	56.1	8.2	6	9
22 Apr	178.5	51.3	8.0	7	10
23 Apr	172.8	51.7	8.0	1	1

Appendix Table 7. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
24 Apr	179.2	51.7	8.3	2	3
25 Apr	170.7	50.1	8.2	8	11
26 Apr	162.3	57.4	8.5	1	2
27 Apr	160.0	48.2	9.1	2	3
28 Apr	172.7	51.3	9.6	4	6
29 Apr	180.6	61.2	9.0	2	3
30 Apr	173.6	50.4	9.0	1	1
01 May	168.7	56.7	8.8	1	2
02 May	156.8	41.5	8.8	1	1
03 May	135.3	36.2	8.8	0	0
04 May	136.3	40.7	9.1	2	3
05 May	134.1	30.1	9.7	0	0
06 May	137.7	27.4	10.0	0	0
07 May	153.7	37.4	10.2	0	0
08 May	155.0	39.1	9.9	0	0
09 May	148.9	37.5	11.0	1	1
10 May	159.0	46.8	11.0	1	1
11 May	167.7	63.6	11.3	0	0
12 May	174.0	62.8	11.6	0	0
13 May	179.6	68.2	11.6	0	0
14 May	196.0	86.9	11.7	1	2
15 May	201.6	83.9	11.4	0	0
16 May	212.7	86.9	11.4	1	2
17 May	224.7	101.9	11.4	0	0

Appendix Table 7. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
18 May	225.3	101.1	11.0	1	2
19 May	208.0	83.7	11.0	0	0
20 May	191.3	85.1	11.0	0	0
21 May	185.6	69.0	11.4	0	0
22 May	178.5	66.6	11.5	0	0
23 May	173.6	55.2	11.5	0	0
24 May	171.4	75.3	11.5	0	0
25 May	165.0	62.2	11.3	0	0
26 May	152.9	56.4	10.9	1	2
27 May	145.7	39.3	11.1	1	1
28 May	142.0	30.9	11.9	0	0
29 May	144.2	49.3	12.3	0	0
30 May	151.2	43.4	12.6	0	0
31 May	163.6	57.4	12.7	1	2
01 Jun	179.5	64.3	12.6	0	0
02 Jun	191.4	72.9	12.7	0	0
03 Jun	183.4	71.8	12.3	0	0
04 Jun	177.7	73.3	12.1	1	2
05 Jun	184.7	81.2	11.9	0	0
06 Jun	188.5	83.4	11.9	0	0
07 Jun	178.1	83.0	12.2	0	0
08 Jun	173.1	89.8	12.6	0	0
09 Jun	169.4	77.1	13.2	0	0
10 Jun	174.2	75.9	14.0	0	0

Appendix Table 7. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
11 Jun	182.1	98.8	13.9	0	0
12 Jun	192.7	89.1	13.5	2	4
13 Jun	187.6	84.9	13.2	1	2
14 Jun	180.8	87.4	13.1	0	0
15 Jun	189.8	100.9	13.8	1	2
16 Jun	187.3	84.0	14.7	0	0
17 Jun	184.0	83.4	14.9	0	0
18 Jun	178.9	75.6	14.8	0	0
19 Jun	178.5	66.0	14.8	0	0
20 Jun	168.4	68.2	15.3	0	0
21 Jun	159.5	58.5	15.6	2	3
22 Jun	147.8	55.1	15.6	1	2
23 Jun	138.9	46.2	15.6	0	0
24 Jun	123.4	22.9	15.9	0	0
25 Jun	109.2	1.6	16.2	0	0
26 Jun	103.7	6.3	16.7	1	1
27 Jun	105.4	2.3	16.8	0	0
28 Jun	108.9	10.5	16.9	0	0
29 Jun	110.1	4.7	17.3	0	0
30 Jun	101.9	0.0	17.5	0	0
01 Jul	100.5	0.0	17.5	0	0
02 Jul	107.2	5.9	17.3	1	1
03 Jul	95.3	5.9	16.8	0	0
04 Jul	89.9	6.0	16.9	0	0

Appendix Table 7. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
05 Jul	85.9	6.0	17.0	0	0
06 Jul	82.0	1.7	17.6	0	0
07 Jul	73.7	0.0	17.9	0	0
08 Jul	70.6	2.8	18.5	0	0
09 Jul	68.2	0.0	18.8	0	0
10 Jul	72.9	0.0	18.7	0	0
11 Jul	69.3	4.1	18.8	1	1
12 Jul	57.7	1.8	18.3	0	0
13 Jul	56.7	4.1	18.2	0	0
14 Jul	54.1	1.8	18.8	0	0
15 Jul	62.5	5.5	18.5	0	0
16 Jul	64.6	7.7	18.9	0	0
17 Jul	64.3	5.9	20.0	0	0
18 Jul	63.8	2.9	19.3	0	0
19 Jul	64.1	0.0	19.3	0	0
20 Jul	68.5	2.6	19.3	0	0
21 Jul	62.3	2.0	19.0	0	0
22 Jul	62.8	4.1	18.8	0	0
23 Jul	62.7	5.9	18.9	1	1
22 Sep	40.1	0.0	19.7	1	1

Appendix Table 8. Daily detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Little Goose Dam during 1997, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam. Numbers detected represent fish not detected at a previous dam. Adjusted numbers detected are calculated during spill.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperatures (°C)	Numbers detected	Adjusted numbers detected
15 Apr	81.7	26.5	9.2	0	0
16 Apr	89.6	26.4	9.0	0	0
17 Apr	103.1	24.2	9.0	0	0
18 Apr	109.5	22.3	8.9	1	1
19 Apr	122.0	31.6	9.1	1	1
20 Apr	153.2	40.8	9.3	1	1
21 Apr	177.0	55.8	9.5	5	7
22 Apr	176.7	55.0	9.9	2	3
23 Apr	168.7	52.1	9.4	2	3
24 Apr	181.3	64.4	9.3	0	0
25 Apr	163.7	52.6	10.0	1	1
26 Apr	158.5	78.1	10.1	3	6
27 Apr	152.4	52.7	9.8	0	0
28 Apr	169.5	63.6	10.2	0	0
29 Apr	175.2	73.7	10.8	2	3
30 Apr	170.3	67.1	10.6	2	3
01 May	164.2	62.3	10.2	1	2
02 May	153.0	61.4	10.5	1	2
03 May	131.4	44.4	10.2	0	0
04 May	132.4	51.8	10.2	0	0
05 May	134.1	41.8	10.5	0	0
06 May	134.0	35.4	10.8	1	1

Appendix Table 8. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperatures (°C)	Numbers detected	Adjusted numbers detected
07 May	144.9	40.1	11.6	0	0
08 May	150.9	40.4	11.5	0	0
09 May	143.4	39.2	11.2	0	0
10 May	149.9	51.2	10.9	0	0
11 May	160.3	53.4	11.3	1	1
12 May	167.4	73.4	11.4	1	2
13 May	169.1	80.3	11.6	0	0
14 May	189.9	83.8	11.8	1	2
15 May	189.1	73.0	11.7	0	0
16 May	207.6	93.2	11.7	0	0
17 May	212.2	98.4	11.5	1	1
18 May	217.3	102.6	11.5	1	2
19 May	197.3	85.5	11.1	0	0
20 May	184.8	80.7	11.0	0	0
21 May	173.7	88.1	11.0	1	2
22 May	173.8	90.5	11.4	0	0
23 May	165.9	68.4	11.5	1	2
24 May	163.2	76.7	11.5	0	0
25 May	155.7	71.5	11.5	0	0
26 May	145.9	61.2	11.4	0	0
27 May	140.0	52.1	11.4	1	2
28 May	137.4	53.2	11.2	1	2
29 May	138.4	74.8	11.5	0	0
30 May	146.3	44.9	12.5	0	0

Appendix Table 8. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperatures (°C)	Numbers detected	Adjusted numbers detected
31 May	161.9	47.7	12.6	0	0
01 Jun	173.4	58.3	12.8	0	0
02 Jun	182.7	67.4	12.7	0	0
03 Jun	175.0	60.5	12.7	0	0
04 Jun	171.4	62.1	12.3	0	0
05 Jun	176.5	67.2	12.2	0	0
06 Jun	182.4	69.5	12.2	0	0
07 Jun	168.1	62.4	12.1	0	0
08 Jun	164.8	73.3	12.1	0	0
09 Jun	163.5	64.1	12.6	0	0
10 Jun	166.9	61.0	13.1	1	2
11 Jun	174.2	67.0	13.7	0	0
12 Jun	185.8	77.9	13.9	0	0
13 Jun	179.4	64.4	13.7	0	0
14 Jun	175.0	64.8	13.5	0	0
15 Jun	183.0	70.6	13.2	0	0
16 Jun	179.3	72.5	13.6	0	0
17 Jun	172.3	92.0	14.4	0	0
18 Jun	169.8	80.4	14.8	0	0
19 Jun	171.1	67.6	14.8	0	0
20 Jun	161.6	74.1	14.8	0	0
21 Jun	150.5	68.4	15.0	1	2
22 Jun	142.5	59.4	15.3	0	0
23 Jun	132.0	47.5	15.5	0	0

Appendix Table 8. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperatures (°C)	Numbers detected	Adjusted numbers detected
23 Jun	132.0	47.5	15.5	0	0
24 Jun	122.2	21.0	15.5	0	0
25 Jun	111.9	8.9	15.8	0	0
26 Jun	101.6	0.0	16.0	0	0
27 Jun	104.8	0.0	16.2	1	1
28 Jun	106.8	13.8	16.8	0	0
29 Jun	110.2	6.5	16.8	0	0
30 Jun	101.1	0.0	16.9	0	0
01 Jul	100.8	0.0	17.0	0	0
02 Jul	106.3	2.9	17.3	0	0
03 Jul	92.6	0.0	18.3	0	0
04 Jul	87.6	0.0	19.2	0	0
05 Jul	84.9	0.0	17.1	0	0
06 Jul	79.7	0.0	16.8	0	0
07 Jul	70.6	0.0	16.8	0	0
08 Jul	71.1	0.0	17.3	0	0
09 Jul	68.4	0.0	17.6	0	0
10 Jul	71.0	0.0	17.7	1	1
30 Aug	28.5	0.0	20.9	1	1

Appendix Table 9. Daily detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Lower Monumental Dam during 1997, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam. Numbers detected represent fish not detected at a previous dam(s). Adjusted numbers detected are calculated during spill.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperatures (°C)	Numbers detected	Adjusted numbers detected
20 Apr	163.6	49.5	10.7	0	0
21 Apr	191.3	72.9	9.5	0	0
22 Apr	192.4	71.6	9.2	0	0
23 Apr	179.7	61.5	9.6	1	2
24 Apr	198.6	83.5	9.1	2	3
25 Apr	178.8	58.9	8.7	1	1
26 Apr	172.6	66.8	9.0	3	5
27 Apr	164.0	62.1	9.1	1	2
28 Apr	183.1	69.5	10.3	2	3
29 Apr	193.2	74.9	10.8	0	0
30 Apr	186.8	68.2	11.4	1	2
01 May	177.1	61.1	----	0	0
02 May	167.1	53.0	----	0	0
03 May	142.7	42.2	----	0	0
04 May	139.8	40.3	----	1	1
05 May	142.3	37.5	9.9	0	0
06 May	143.7	37.3	10.1	0	0
07 May	153.8	38.7	10.4	0	0
08 May	159.3	41.2	10.9	0	0
09 May	154.1	39.8	11.2	0	0
10 May	159.0	47.2	11.5	0	0
11 May	169.9	56.3	11.4	0	0

Appendix Table 9. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperatures (°C)	Numbers detected	Adjusted numbers detected
12 May	178.6	63.6	11.5	0	0
13 May	183.4	66.5	11.5	0	0
14 May	205.1	91.4	11.9	0	0
15 May	205.3	87.4	12.1	0	0
16 May	222.7	104.0	12.1	0	0
17 May	231.1	115.1	11.8	0	0
18 May	236.3	121.3	11.8	0	0
19 May	214.3	101.4	11.6	0	0
20 May	197.4	84.3	11.3	2	3
21 May	188.9	77.3	11.3	0	0
22 May	186.9	71.7	11.3	0	0
23 May	173.8	65.3	11.5	1	2
24 May	173.1	71.8	11.6	2	3
25 May	171.5	68.3	11.6	0	0
26 May	153.6	56.3	11.6	1	2
27 May	146.5	41.5	11.7	0	0
28 May	145.2	41.2	11.7	0	0
29 May	148.5	51.8	11.5	0	0
30 May	151.7	42.8	11.7	1	1
31 May	171.5	66.1	12.3	0	0
01 Jun	182.7	72.9	12.8	0	0
02 Jun	195.6	75.2	13.0	0	0
03 Jun	184.6	71.9	13.0	0	0
04 Jun	182.9	72.8	12.8	0	0

Appendix Table 9. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperatures (°C)	Numbers detected	Adjusted numbers detected
05 Jun	189.1	81.6	12.5	0	0
06 Jun	193.7	89.5	12.4	0	0
07 Jun	184.5	88.6	12.3	0	0
08 Jun	176.0	92.7	12.3	0	0
09 Jun	175.0	85.6	12.3	1	2
10 Jun	175.4	81.1	12.8	0	0
11 Jun	186.7	104.4	13.2	0	0
12 Jun	200.2	96.7	13.8	0	0
13 Jun	191.6	93.6	14.1	0	0
14 Jun	186.4	94.2	13.9	1	2
15 Jun	194.3	107.1	13.8	0	0
16 Jun	192.2	97.5	13.6	0	0
17 Jun	184.7	87.5	13.9	0	0
18 Jun	183.3	81.3	14.5	0	0
19 Jun	185.3	71.3	14.9	1	2
20 Jun	170.7	72.4	14.9	0	0
21 Jun	157.6	56.3	14.9	0	0
22 Jun	153.5	53.4	14.9	0	0
23 Jun	140.8	48.9	15.3	0	0
24 Jun	126.4	19.4	15.5	0	0
25 Jun	121.2	8.8	15.7	0	0
26 Jun	107.4	2.5	15.9	0	0
27 Jun	114.7	0.0	16.2	0	0
28 Jun	113.2	10.2	16.3	0	0

Appendix Table 9. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperatures (°C)	Numbers detected	Adjusted numbers detected
29 Jun	118.9	3.7	16.5	1	1
30 Jun	109.8	0.0	16.8	1	1
01 Jul	107.3	13.7	16.9	0	0
02 Jul	111.9	23.1	17.2	0	0
03 Jul	100.8	3.3	18.0	0	0
04 Jul	93.6	2.3	18.6	1	1

Appendix Table 10. Daily detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at McNary Dam during 1997, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam. Numbers detected represent fish not detected at a previous dam(s). Adjusted numbers detected are calculated during spill.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
20 Apr	295.1	129.4	9.1	0	0
21 Apr	321.4	155.3	9.4	0	0
22 Apr	399.2	234.2	9.5	0	0
23 Apr	414.0	249.3	9.1	0	0
24 Apr	424.1	258.9	9.2	1	3
25 Apr	404.0	239.5	9.3	0	0
26 Apr	402.8	236.2	9.3	1	2
27 Apr	400.7	237.4	9.2	0	0
28 Apr	400.9	234.0	9.4	1	2
29 Apr	441.6	276.1	9.3	0	0
30 Apr	451.8	287.4	9.3	0	0
01 May	455.6	291.0	9.4	1	3
02 May	435.9	270.7	9.5	0	0
03 May	402.5	232.2	9.6	0	0
04 May	394.7	231.6	9.7	0	0
05 May	389.6	216.5	9.9	0	0
06 May	388.4	214.2	10.1	0	0
07 May	377.5	199.6	10.5	0	0
08 May	397.3	218.4	10.5	0	0
09 May	394.1	218.1	10.8	0	0
10 May	392.0	215.5	11.1	0	0
11 May	400.1	221.4	11.4	0	0

Appendix Table 10. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
12 May	432.6	259.0	11.7	0	0
13 May	428.6	251.4	11.9	0	0
14 May	477.9	299.7	12.0	0	0
15 May	468.2	292.5	12.3	0	0
16 May	478.3	298.6	12.5	0	0
17 May	519.2	344.1	12.6	0	0
18 May	524.0	345.5	12.6	1	3
19 May	518.0	341.6	12.3	0	0
20 May	495.7	332.9	12.1	0	0
21 May	513.6	345.3	12.0	0	0
22 May	487.6	317.4	12.0	1	3
23 May	495.5	332.8	11.8	2	6
24 May	460.4	339.2	11.9	0	0
25 May	465.3	336.7	11.9	0	0
26 May	457.1	312.2	12.3	0	0
27 May	452.0	301.0	12.3	1	3
29 Jun	335.0	173.3	----	1	2

Appendix Table 11. Monthly flow information from August 1996 through July 1997 in cubic feet per second (cfs) for various sites in the Salmon River drainage in Idaho. These data were provided by the U. S. Geological Survey and is cited as provisional data subject to revision.

Flow	Agust	Septembe r	October	November	December	January	February	March	April	May	June	July
					Station number 13295000--Valley Creek at Stanley, ID							
Mean	162	108	102	165	123	221	115	131	294	910	1,105	412
Min	108	---	89	78	84	129	95	93	150	414	630	274
Max	267	136	127	718	220	487	165	200	586	1,370	1,600	729
					Station number 13302500--Salmon River at Salmon, ID							
Mean	1,398	1.077	1,308	1,535	1,364	1,729	1,291	1,418	2,150	7,435	11,500	3,985
Min	1,090	956	1,140	1,270	1,050	1,270	1,190	1,120	1,410	2,870	6,080	2,650
Max	2,100	1,200	1,540	2,760	1,770	3,240	1,690	2,020	3,670	12,400	16,200	6,580
					Station number 13310700--South Fork Salmon River near Krassel Ranger Station, ID							
Mean	---	163	147	409	417	860	351	488	1,210	3,208	2,321	594
Min	---	145	128	133	240	343	262	251	538	1,440	1,020	342
Max	---	232	182	2,220	1,580	3,640	568	945	2,840	5,740	4,000	1,090
					Station number 13314300--South Fork Salmon River at mouth near Mackay Bar, ID							
Mean	974	675	664	1,252	1,227	2,466	1,097	1,393	3,147	11,080	9,827	2,437
Min	733	588	595	524	729	1,250	856	812	1,520	3,860	4,220	1,370
Max	1,430	850	773	6,460	3,430	8,680	1,610	2,480	7,360	19,400	16,200	4,460
					Station number 13317000--Salmon River at White Bird, ID							
Mean	6,899	4,931	4,878	7,057	6,661	11,480	6,400	9,199	18,500	59,100	60,340	17,660
Min	5,350	4,550	4,440	4,830	4,610	6,280	5,470	5,360	9,410	23,900	28,700	10,900
Max	10,100	5,320	5,570	19,100	13,100	35,500	8,230	17,100	34,800	98,900	82,400	30,000

Appendix Table 12. Monthly environmental data collected from Marsh Creek (RKm 179.5 from the mouth of the Middle Fork Salmon River) from August 1996 through July 1997.

	August	September	October	November	December	January	February	March	April	May	June	July
						Temperature (°C)						
Minimum	5.8	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	5.2
Maximum	17.9	14.9	11.4	5.1	1.9	2.8	4.6	7.7	8.7	13.0	14.2	18.3
Average	11.5	7.8	4.3	1.1	0.2	0.4	0.8	2.0	2.5	4.5	8.2	11.3
						Dissolved Oxygen (ppm)						
Minimum	-----	-----	-----	-----	-----	-----	-----	-----	9.9	-----	-----	-----
Maximum	-----	-----	-----	-----	-----	-----	-----	-----	11.8	-----	-----	-----
Average	-----	-----	-----	-----	-----	-----	-----	-----	10.8	-----	-----	-----
						Specific Conductance (μS/cm)						
Minimum	54.7	42.3	55.6	32.0	40.0	40.0	40.0	30.0	39.0	22.0	28.0	39.0
Maximum	64.3	64.2	65.0	65.0	60.0	50.0	50.0	68.0	68.0	53.0	44.0	58.0
Average	59.9	61.3	60.8	55.2	50.9	47.1	40.7	43.5	58.0	36.4	35.9	51.2
						Turbidity (ntu)						
Minimum	-----	-----	-----	-----	-----	-----	-----	-----	0.2	2.5	2.3	1.0
Maximum	-----	-----	-----	-----	-----	-----	-----	-----	16.7	34.5	46.5	21.0
Average	-----	-----	-----	-----	-----	-----	-----	-----	3.5	8.1	4.5	2.1

Appendix Table 12. Continued.

	August	September	October	November	December	January	February	March	April	May	June	July
					Depth (feet)							
Minimum	1.6	1.4	1.1	1.1	0.8	0.9	0.6	0.8	0.9	1.8	2.6	2.1
Maximum	2.3	1.9	2.0	2.6	2.9	3.4	2.2	1.7	2.1	4.6	4.6	3.2
Average	2.0	1.7	1.6	1.6	1.5	1.7	1.4	1.3	1.5	3.4	3.7	2.5
					Flow (cfs)							
Minimum	95.3	73.4	55.4	56.5	42.3	49.7	33.8	44.7	46.6	109.3	219.1	139.8
Maximum	161.4	124.8	135.5	208.3	259.6	376.0	148.1	95.1	142.3	818.8	856.3	330.2
Average	128.5	100.8	96.9	96.6	93.7	114.0	78.2	69.2	87.1	425.3	488.4	195.2
					pH							
Minimum	7.6	7.6	7.6	6.9	7.1	6.9	7.2	7.3	7.0	6.8	7.2	7.3
Maximum	8.5	8.6	8.9	9.2	7.5	7.5	7.7	7.7	7.8	7.6	7.6	8.3
Average	7.9	7.9	7.9	7.7	7.4	7.2	7.4	7.4	7.4	7.2	7.4	7.6

Appendix Table 13. Monthly environmental data collected from the Salmon River near Sawtooth Hatchery (RKm 627.9) from August 1996 through July 1997.

	August	September	October	November	December	January	February	March	April	May	June	July
						Temperature (°C)						
Minimum	8.4	----	----	----	0.0	0.0	0.0	----	0.3	2.1	6.3	7.5
Maximum	18.7	----	----	----	3.5	4.3	5.9	----	11.5	14.0	15.1	18.7
Average	13.7	----	----	----	1.1	1.2	1.5	----	5.1	7.7	10.3	13.2
						Dissolved Oxygen (ppm)						
Minimum	----	----	----	----	----	----	----	----	8.7	8.3	7.8	7.1
Maximum	----	----	----	----	----	----	----	----	13.6	12.5	11.7	11.8
Average	----	----	----	----	----	----	----	----	11.6	10.3	9.5	9.0
						Specific Conductance (μS/cm)						
Minimum	114.0	----	----	----	140.0	110.0	150.0	----	99.0	55.0	47.0	64.0
Maximum	158.0	----	----	----	180.0	170.0	190.0	----	133.0	110.0	69.0	91.0
Average	140.0	----	----	----	157.7	149.8	170.4	----	117.9	76.8	57.6	76.5
						Depth (feet)						
Minimum	1.8	----	----	----	0.9	1.1	0.8	----	0.9	1.5	1.3	0.9
Maximum	2.6	----	----	----	2.1	2.5	2.1	----	2.3	3.4	3.0	1.7
Average	2.2	----	----	----	1.4	1.7	1.6	----	1.7	2.2	2.2	1.3

Appendix Table 13. Continued.

	August	September	October	November	December	January	February	March	April	May	June	July
					pH							
Minimum	8.0	----	----	----	7.9	7.6	7.9	----	7.6	7.5	7.4	7.5
Maximum	9.1	----	----	----	8.6	8.9	9.0	----	8.9	8.7	8.1	8.4
Average	8.5	----	----	----	8.1	8.1	8.3	----	8.0	7.8	7.6	7.8

Appendix Table 14. Monthly environmental data collected from Valley Creek (RKm 609.4 from the mouth of the Salmon River) from August 1996 through July 1997.

	August	September	October	November	December	January	February	March	April	May	June	July
						Temperature (°C)						
Minimum	----	----	----	----	0.3	0.3	0.3	0.2	0.3	----	----	----
Maximum	----	----	----	----	2.3	2.0	4.6	9.5	10.1	----	----	----
Average	----	----	----	----	0.7	0.6	1.0	2.7	3.5	----	----	----
						Dissolved Oxygen (ppm)						
Minimum	----	----	----	----	12.7	6.7	----	----	----	----	----	----
Maximum	----	----	----	----	14.5	17.8	----	----	----	----	----	----
Average	----	----	----	----	13.5	14.6	----	----	----	----	----	----
						Specific Conductance (μS/cm)						
Minimum	----	----	----	----	60.0	42.0	67.0	70.0	43.0	----	----	----
Maximum	----	----	----	----	85.0	77.0	95.0	92.0	85.0	----	----	----
Average	----	----	----	----	74.5	63.4	78.8	82.0	66.5	----	----	----
						Turbidity (ntu)						
Minimum	----	----	----	----	----	----	----	3.0	1.7	----	----	----
Maximum	----	----	----	----	----	----	----	9.3	42.9	----	----	----
Average	----	----	----	----	----	----	----	4.2	6.7	----	----	----

Appendix Table 14. Continued.

	August	September	October	November	December	January	February	March	April	May	June	July
					Depth (feet)							
Minimum	----	----	----	----	0.7	1.0	0.6	0.9	1.1	----	----	----
Maximum	----	----	----	----	1.9	2.3	1.8	1.8	3.0	----	----	----
Average	----	----	----	----	1.2	1.7	1.4	1.4	1.9	----	----	----
					pH							
Minimum	----	----	----	----	7.2	7.0	7.2	7.1	6.9	----	----	----
Maximum	----	----	----	----	8.0	8.1	8.5	8.8	8.3	----	----	----
Average	----	----	----	----	7.6	7.3	7.6	7.7	7.3	----	----	----